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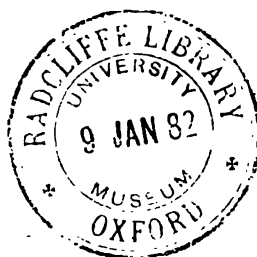


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ON GROVE'S, PLANTÉ'S, AND FAURE'S SECONDARY BATTERIES.*

By Prof. W. GRYLLS ADAMS, M.A., F.R.S., &c.

THE effects on which the action of secondary batteries depends have long been known, in fact the history of secondary batteries is almost as ancient as the history of Voltaic Electricity. It might even be said that the history of secondary batteries is older than the history of voltaic batteries, for in 1795 Galvani noticed that when shocks from an electric eel were given to the nerves of a frog, it was possible to obtain an electric shock by holding the leg of the frog in one hand and touching the nerves with the other. In a note-book of Galvani's which was exhibited at the Electrical Exhibition in Paris, 1881, Galvani gives an account of these experiments, and supposes "that the electric eel had transmitted a part of its electricity to the frog, which was capable of holding the charge and giving it out again," and he even supposes that after being discharged it might again receive a charge, and might give it out again when required. In the year 1800 Volta discovered his battery or pile, which gave the method of producing electric currents through the agency of chemical actions, and in the year 1801 Gautherot, a scientific Frenchman, observed that when wires of silver or wires of platinum were used for the decomposition of the acidulated water, the two wires gave a current of electricity after they were detached from the battery. This was termed the polarisation current, and the effect was said to be due to polarisation; a convenient term introduced to express something, the meaning of which was not understood.

Only two years later, in 1803, Ritter, of Jena, observed a similar effect when using gold wires for the decomposition of water, and it occurred to him to devise a battery for producing and making use of these secondary currents. He made use of various metals, and succeeded in getting strong effects with platinum and with silver wires; he also succeeded in getting currents of electricity with iron wires, with brass, and also with bismuth, using water slightly diluted with acid for his liquid. It also occurred to him to make use of lead, but with this metal he did not succeed in getting a current, because with it he used a solution of chloride of lead, which is a non-conductor, or offered too high a resistance to produce any effect which could be ob-

served. Thus within three years of the discovery of Voltaic Electricity Ritter had discovered and made use of secondary batteries. He charged fifty cells of a secondary battery by means of 100 couples of Volta's pile, and produced different chemical and physiological effects, such as were produced by the original battery. This secondary action was attributed to an absorption, or soaking in, of the two opposite kinds of electricity by the metals, and the current obtained was called a polarisation current. The investigations of Volta and Marianini gave clearer ideas with regard to this secondary action, and after them Becquerel, by his investigations on batteries with platinum plates and two different liquids, showed that in the secondary batteries the liquids immediately surrounding the two plates were no longer in the same state, but that there were present all the elements which were required to produce a voltaic battery, *i.e.*, two different substances united by a liquid conductor in which chemical action could take place. Different theories were started to account for the action.

In the year 1805, Grotthuss, writing on the decomposition of liquids by voltaic electricity, regarded the poles as attracting the two opposite kinds of electricity. The pole from which resinous electricity issues attracts hydrogen and repels oxygen, whilst the pole from which positive electricity issues attracts oxygen and repels hydrogen. In 1806 Sir Humphry Davy also supposes the decomposition and giving off of gas to be due to the attractions of the poles, and that the decomposition and recombination go on throughout the fluid from one particle to another of the fluid, the gases or decomposed bodies only appearing separate at the poles.

In 1825 De la Rive explained the action as being due to an affinity or combination of the elements with the electric currents. The current from the positive pole combining with the hydrogen or the bases it finds there, leaves the oxygen or the acids at liberty, but carries the substances it is united with across to the negative pole, where it enters the metal conductor and leaves the hydrogen or base on the surface. In the same way the electricity from the negative pole sets the hydrogen or base which it finds there free, but unites with the oxygen or acid and carries them across to the positive pole, and there leaves them.

De la Rive does not admit that there is successive decomposition and recombination going on in the course of the electric currents throughout the liquid, but regards the decomposition as only taking place at the poles.

Thus far had opinions advanced when Faraday attacked the subject, in 1833, and set the whole theory of electrica

* A Paper read before the Science Society of King's College, London, Tuesday, October 25, 1881.

decomposition on a firm basis in his four series of papers communicated to the Royal Society between June, 1833, and March, 1834. I have not time for more than a passing allusion to the laws of electrolysis which he established, and to his opinions on the relation of electricity to chemical action, which are now well known. How he established that the sum of chemical decomposition is constant for any section taken across a decomposing conductor. That for a constant quantity of electricity the amount of electrochemical action is also a constant quantity, whatever the decomposing conductor may be, whether water, salt solutions, acids, fused bodies, &c.; the quantities of substances decomposed by the same current being in proportion to their mutual chemical affinities; and how he concluded that "the forces termed chemical affinity and electricity are one and the same. That the evolved substances appear only at the poles, because everywhere else each particle finds other particles having a contrary tendency with which it can combine."

Thus Faraday traces the decomposition to the action or modification of the internal forces in the molecules decomposed rather than to external forces like the attractions of the poles upon them. The poles are merely the doors by which the electricity enters or leaves the electrolyte and metals, and even gases may be used as poles.

In this series of experiments he devised his volta-electrometer or voltameter, with which he fully established the law that "The chemical power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes."

In explaining the action which he regards as going on in the battery, he says—"I suppose that the effects are due to a modification by the electric current of the chemical affinity of the particles through which or by which that current is passing, giving them the power of acting more forcibly in one direction than in another, making them travel by a series of successive decompositions and recompositions in opposite directions, and finally causing their expulsion from the mass of liquid when they reach the poles." In this series of papers he very powerfully sums up his reasoning as to the identity of voltaic electricity and the electricity of the machine. He says:—"One grain of water, acidulated to facilitate conduction, will require an electric current to be continued for three minutes and three-quarters to effect its decomposition, which current must be powerful enough to retain a platinum wire $\frac{1}{16}$ th of an inch in thickness red-hot in the air during the whole time; and if interrupted anywhere by charcoal points, will produce a very brilliant and constant star of light, and the beautiful experiments of Wheatstone have shown that this quantity of electricity is equal to a very powerful flash of lightning; yet we have it under perfect command, and when it has performed its full work of electrolysis it has only separated the elements of a single grain of water.

In the same paper he clearly states the laws of the transformation of energy, and enunciates the important principle of the Conservation of Energy, which now forms the bond between the various physical sciences.

He says:—"Considering the twofold relation that without decomposition transmission of electricity does not occur, and that for a definite quantity of electricity a definite quantity of electricity is decomposed, it seems a natural consequence that the quantity passed is the equivalent of the chemical affinity of the particles separated; i.e., that if the electrical power which holds the elements of a grain of water in combination, or which makes a grain of oxygen and hydrogen in the right proportions unite into water, could be thrown into the condition of a current, it would exactly equal the current required for the separation of that grain of water into its elements again."

Among the causes of the diminution in force of the voltaic battery Faraday includes what he calls the peculiar state acquired by the metal surfaces in the second vessel (i.e., the negative pole), which caused them to oppose the passing current by the force of a secondary current. Hence

he draws practical conclusions, that weak and exhausted cells should never be used with strong and fresh ones. Thus fifty cells, with ten of them not charged equally to the rest, gave nine-tenths of a cubic inch of gases in half a minute, whereas the forty good cells gave $4\frac{1}{2}$ cubic inches in the same time.

In the course of his experiments on this subject Faraday frequently found apparent contradictions to his simple law of electrolysis, but he was led to refer all deviations from it to the action of secondary currents; as, for instance, in the evolution of nitrogen at the positive, and hydrogen at the negative, pole in a voltameter containing sulphate of ammonia dissolved in a strong solution of ammonia. The hydrogen as measured by a voltameter was obtained from the decomposed water, whilst the nitrogen was a secondary result depending upon the chemical action of oxygen at the positive pole.

He may almost be said to have discovered a secondary battery similar to that of M. Planté or M. Faure, when using acetate of lead for his solution he finds that the results at both electrodes are secondary; peroxide of lead appearing at the positive, and lead itself at the negative pole.

Whether, as was at first supposed, under the influence of the primary current, the metal electrodes acquired a sort of static charge, positive on one and negative on the other, thus producing a polarisation current, or whether the whole of the secondary current might be regarded as due to the deposition and absorption of gases decomposed from the liquid, so altering the surfaces of the electrodes, and therefore converting a voltameter into a battery cell, might still be regarded as an unsettled question. In 1843 Grove gave an important contribution towards its solution when he invented his gas battery, in which two platinum plates were immersed, one in oxygen and the other in hydrogen, thus forming a secondary battery which could be employed for the storing up of electrical energy. Grove's gas battery may be said to be a voltameter in which the platinum plates extend throughout the height of the tubes for collecting the gases of the voltameter, and are attached to platinum wires sealed into the glass at the top of the tubes. After a current from a battery has passed through the voltameter it is detached from the battery, and the two platinum wires of the voltameter are at different potential and give a secondary current when they are brought in contact or attached to a galvanometer. This current, as in all cases of secondary currents, is in the opposite direction in the cell to the battery current which produced the decomposition. This may be readily seen on charging the Grove's gas battery and then testing the difference of potential of its poles by means of a quadrant electrometer, by which means we may compare it with a standard battery and determine its electromotive force. We may also unite the poles to a galvanometer with a resistance or shunt to take off the greater part of the current, and so may measure the current which this battery will send through a known resistance.

In 1852 Dr. C. W. Siemens constructed a secondary battery on the plan of Grove, with carbon plates for his poles in place of platinum, and in order to increase the effects he inserted the carbons in a strong solution of acetate of lead, so that, on passing the battery current through the cell, peroxide of lead was deposited on one of the poles, and the secondary battery was formed. The electromotive force of this battery was such that one cell of it was sufficient to produce the decomposition of water. Hence the electromotive force must have been nearly equal to two volts. The volt is the unit of electromotive force which has for some time been in use in England, but which has only quite recently, at the Paris Congress of Electricians, been generally received throughout the whole of Europe. Its value is very nearly the same as the electromotive force of one Daniell's cell, so that we may conveniently make use of a Daniell's cell for our standard of comparison for electromotive forces.

In order to find what current a battery of given electro-

motive force will send through a given resistance in a unit of time, we may make use of Ohm's law that $C = \frac{E}{R+r}$ —or, as we may put it, $E = C(R+r)$. The resistance ($R+r$) is expressed in ohms, which has long been the English unit of resistance, but which has only now, viz., at the Paris Congress, been accepted by Europe as the unit of resistance.

The equation $E = C(R+r)$ requires that if the electromotive force is one volt and the resistance of the circuit is one ohm, then the current must be equal to one unit of current; if $E = 1$ and $R+r = 1$, then $C = 1$, i. e., the unit of current is the current which a volt will send per second through an ohm. The name lately given to this current in England was the Weber; but since the Germans have been accustomed to use the Weber in a different sense, it has been thought better at the Paris Congress to drop the name of Weber for the unit of current, and France and Germany, and other countries, have agreed by their representatives at the Congress, and with the consent of the practical men present at the International Exhibition, to call the union of current an *Ampère*,—so that what we have been accustomed to call a *Weber* has now been called an *Ampère*, and is the current which an electromotive force of one volt sends per second through a resistance of one ohm.

For the sake of uniformity and to prevent confusion the German scientific men and practical electricians have agreed to accept the English ohm as their unit of resistance, and to give up the mercury unit, or metre of mercury, which they have always been accustomed to employ. Into the relations of these units to what are called the C. G. S. system of units, I will not now enter. Now that we come to the storing up of electrical energy in secondary batteries there is the necessity for another unit, viz., the unit of quantity stored up in a battery without regard to time. For the current flowing in a circuit is the quantity of electricity per second. We cannot define the current which a secondary battery can give without giving the resistance of the circuit, but we can state that a given secondary battery will be of a certain electromotive force, and will store up a certain quantity of electricity ready for use when required.

The name which has been accepted at Paris for the unit of quantity is the *Coulomb*, so that, according to the latest acceptance, the amount of energy stored up in a secondary battery may be expressed in *Volt-Coulombs*.

We may store up electrical energy of very high potential in a Leyden jar or condenser, and make use of it at intervals instead of taking it continuously from an electrical machine. We cannot raise the potential of the charge in a Leyden jar any higher than the potential of the machine from which it is charged. We may as well expect heat to flow from a cold body to a hot one and make it hotter, or think that we can get water of its own accord to flow up a hill into a reservoir at the top. In connection with this question of storage of energy it may help us to trace the analogy between difference of potential with regard to electricity and difference of level with regard to the force of gravity.

The difference of potential giving rise to electromotive forces between two points which are united by a conductor causes a current of electricity from a point of higher to a point of lower potential, just as a difference of level giving rise to pressure between two points in a water channel causes a flow of water from the higher to the lower level. The electromotive force corresponds to pressure, and the resistance of the circuit corresponds to the hindrances to the flow, the current corresponds to the quantity of water flowing per unit of time. Thus of two paths from one level to another, the current will be most rapid along the steepest channel, and in the same way with the same electromotive force, the greatest current will be along the line of least resistance.

The electricity supplied by the electrical machine will be like a very small stream supplied by a pump at a very

great height, and discharging itself by a small pipe at a very much lower level, so that it is capable of exerting very great pressure, but when allowed to run it can do very little work, because the quantity is small.

The Leyden jar is like the reservoir into which the water is pumped at a high level, and when the size of this reservoir is increased we know how difficult it is to prevent leakage from the very great pressure exerted by the water, and how dangerous the bursting and discharge from such a reservoir may be to those on the lower level who may happen to be on the path of the discharge.

On the other hand, the ordinary Grove's battery giving us electricity in abundant quantity, but of small difference of potential, is like a means of obtaining, when required, an ample supply of water, as from a large reservoir not far above the level where it is wanted to be used, and so giving an abundant supply at low pressure. Had this mode of supplying electricity continued to be the principal one, we should probably not have so much need, and should not hear so much, of secondary batteries; for instead of burning up the zinc in the Grove's battery to charge up the secondary battery, like a large reservoir, today, in order that the stored-up electricity may be used to-morrow, it would probably be better not to charge the Grove's battery until to-morrow, and then use it directly to do the work required.

The development of Faraday's discovery that the motion of a coil of wire in front of the poles of a magnet, or in a magnetic field, gives rise to an electric current in the wire, has shown us that the burning of zinc or other materials in batteries such as Grove's or Daniell's is a very expensive way of producing an electric current, and that it is far more economical to obtain electric currents by employing the best mechanical means we have to produce rotation of the coil of wire in the magnetic field. The different magnets and dynamo-electric machines (and they abound) are but the results of attempts to find the best form of coil, the best kind and best form of magnets, the best proportion of resistances, and the most suitable arrangements for the special work in each case which is required to be done.

The dynamo-electric machine driven by a steam-engine, or by a gas-engine, is very satisfactory as a mode of producing electricity, and both the electromotive force and the current increase with the rate of rotation of the coil.

This mode of producing electricity is like raising water to any level that may be required in each particular case, but the electricity must be used at once whilst the steam-engine or the gas-engine is in action. This may be very inconvenient, and hence the necessity for something like a reservoir to store up the electricity.

The labours of Faraday have shown us the relation between the quantity of electricity and the weights of the chemical elements decomposed by it in an electrolyte, and that these chemical elements may unite again to reproduce the same quantity of electricity. The object, then, to attain by means of secondary batteries, is to find some substance which can be decomposed into two others which will remain apart, even when joined by a liquid conductor, until a complete electric circuit is made; then these two substances should be at considerable difference of potential, so as to give a strong electric current in uniting again to form the substance from which they were decomposed.

In 1859 M. Planté, taking advantage of the great affinity of peroxide of lead for hydrogen, made use of this substance to increase the effects of secondary batteries, and so was led to make use of lead electrodes instead of platinum, which had been the metal hitherto employed. He found that better results could be obtained with one cell with lead electrodes than with twenty cells with platinum electrodes.

To form this battery, plates of lead with a finely divided layer of lead upon them are taken as electrodes, a current from two Grove's cells is sent through the cell containing them, immersed in diluted sulphuric acid of strength about

one to ten; the current is sent for a quarter of an hour in one direction, then the cell is fully discharged; the current from the primary battery is then sent through it for a quarter of an hour in the opposite direction, after which the cell is again discharged: in this way it is charged over and over again in opposite directions for longer and longer periods, care being taken each time that the secondary cell is fully discharged. Then the battery is again charged; but when it is capable of giving out the charge slowly enough for the purpose for which it is to be used, then the successive chargings should no longer be given in opposite directions, but always in the same direction. We may say that after the battery is *formed* it should always be charged in the same direction.

In charging by sending a primary current through the cell, peroxide of lead is formed at the positive pole, and the negative pole becomes somewhat crystallised. When detached, the peroxide of lead forms the positive pole of the secondary battery, and the battery will remain in action until the two plates return to the same state, the positive pole being reduced from the peroxide to the oxide of lead, and the negative pole being transformed from lead to the oxide of lead.

M. Planté has especially aimed, by means of his battery, to convert electricity obtained from an ordinary battery into electricity of high tension, to do in a smaller degree what is done by means of the Ruhmkorff induction coil. By means of two cells of Grove or Bunsen he can charge a great number of cells, a dozen or more, arranged for quantity, *i.e.*, with all their positive poles together and all their negative poles together, and when they are charged by arranging them in series—*i.e.*, with the positive pole of one joined to the negative pole of the next—he can get great electromotive force, and at the same time obtain electricity, in great quantity.

By his battery of 800 cells, which he has set up in Paris, and by the aid of his rheostatic machine, which I have not time to describe, he can imitate lightning discharges and remarkable luminous effects, somewhat analogous to the brilliant effects of the Aurora Borealis.

The electromotive force of a single cell of Planté's battery is about $2\frac{1}{2}$ volts, or $2\frac{1}{2}$ times that of a Daniell's cell, *i.e.*, about $1\frac{1}{2}$ times Grove's cell; hence two cells of Grove will charge a Planté cell. The quantity of electricity that may be collected will depend on the amount of chemical action, *i.e.*, on the extent of the surface of the plates, and on the way in which that action has gone on. When the action has gone on rapidly, the battery will not be so good as when the action is slow. The Planté battery, as usually formed, discharges itself too rapidly for many purposes for which electric accumulators are now required, and hence other secondary batteries or modifications of the Planté battery are now making their appearance. The cells may be charged by a dynamo machine, and may also be used to drive a dynamo machine, like an electro-magnetic engine or motor, driving it in the same direction as when it was driven when used as a generator to charge the cells. On attaching the wires from a Planté cell to a small dynamo machine, this machine is converted into a motor and may be employed to work a pump or to do other useful work.

The Planté cell will also heat a platinum wire of considerable diameter, for although the electromotive force is only $2\frac{1}{2}$ volts, yet the quantity is sufficient to make a platinum wire three-tenths m.m. in diameter, and 4 c.m. in length, to glow for half-an-hour.

The secondary battery may be made use of in telegraphy, to do away with the residual magnetism in an electro-magnet, so as to enable it to work more quickly after a current has been sent through it. The secondary cell should be attached with its positive pole to the line and its negative pole to the key, the other end of the line or the earth being also attached to the key so as to form a complete circuit when the key is up; the sending battery, consisting of two or more cells of Grove, or at least three Daniell's cells, should have its negative pole attached to

the negative pole of the secondary cell, and its positive pole to the key, so as to form a complete circuit with the line and secondary cell when the key is down. When contact is made with the sending battery by putting down the signalling key, the current is sent through the secondary cell into the line, thus giving a slight additional charge to the secondary cell and bringing the electro-magnet into action; on breaking contact by releasing the key, the secondary cell, being still connected to the line, sends a reverse current into the line, and weakens, or may even be strong enough to reverse the magnetism of the electro-magnet. If we work a Morse instrument first with the sending battery alone, and afterwards with the secondary cell in the circuit, we find that there is a very great increase in the rate of signalling when the secondary cell is used. The secondary current increases as the battery current increases, and being in the reverse direction, instantly weakens the magnetism of the electro-magnet, so that signals may be sent as fast as the operator can make and break contact.

Another application which M. Planté has made of secondary batteries is for engraving on glass. The glass plate is placed in a shallow dish and covered with a thin layer of a strong solution of nitrate of potash, one platinum wire from the positive pole of the battery is placed in the solution along the edge of the glass plate, and the other platinum wire from the negative pole, sealed in a glass tube for a handle, is used as a pen to trace the form of the required engraving. With slow writing the engraving is deep, and the breadth of the stroke depends upon the diameter of the end of the wire.

The Planté secondary battery has been employed to work an electric break on railway trains. With two Grove's cells or three Daniell's cells, and a Planté cell arranged as above described, the Planté cell is continually being charged, or is kept from getting weaker except when the key is depressed, which completes the electric circuit by which the break is set in action.

The quantity of electricity stored up in six Planté cells, is sufficient, with such an arrangement to prevent the cells from becoming exhausted, to work the brakes on a dozen railway carriages, and to last for a fortnight. To renew the charge in the Planté cells, a battery of six Daniell's cells may conveniently be employed. It is important that the charging should be carried on with great regularity, so that the layer of peroxide of lead may be regularly laid on, otherwise it will not adhere well to the lead electrodes.

Several forms of secondary batteries have appeared quite recently, now that the demand has arisen for a reservoir in which to store up the electricity produced by the dynamo-electric machine, and the secondary action or polarisation of batteries is no longer regarded as something to be avoided as much as possible, but is eagerly sought after. Professors Houston and E. Thomson, of Philadelphia, have tried electrodes of copper in sulphate of zinc. When a current is sent through the cell, zinc is deposited on the negative pole, and sulphate of copper formed around the positive pole, the plates being laid horizontally so that the sulphate of copper so formed and the sulphate of zinc shall be prevented by their relative weights from mixing too readily. This we may call a gravity secondary battery, and its electromotive force will be nearly the same as that of one of Daniell's cell or one volt. M. d'Arsonval modifies this battery by using one electrode of lead and another of zinc in a solution of sulphate of zinc, the lead forming the positive electrode becomes coated as in the Planté cell with peroxide of lead.

Several modifications of Planté's cell have been suggested, which have for their object the reduction of the weight of lead employed; such are the batteries of M. de Pezzer and of M. de Meritens, who fold their laminæ of lead in layers like the leaves of a book, so as to get as much surface as possible for a given weight of lead. M. de Pezzer also finds that the relative size of the positive and negative plates modifies the results obtained, a greater

quantity of electricity is stored up when the negative electrode is double the size of the positive electrode than when the two electrodes are of the same size.

Other modifications, in which the negative pole is either palladium in dilute sulphuric acid, or thin sheet iron in a solution of sulphate of ammonia, have been suggested and employed by M. Rousse, these substances being chosen on account of their great power of absorption of hydrogen. These can hardly be called secondary batteries, since two metals are employed in them as electrodes. The method of charging secondary batteries may sometimes be conveniently made use of to renew ordinary batteries which have become used up. Thus a Leclanché cell which has been in use for a long time and become weak, may be recharged again by connecting up the positive pole of a stronger battery with the positive pole of the Leclanché battery and allowing the current to pass through it for a considerable time. In the same way a dry pile, which has become weak, may have the difference of potential of its two ends increased by sending a current through it from its positive pole to its negative pole; i.e., the positive pole of the battery should be joined to the positive pole of the dry pile. The secondary battery, to which most attention has been drawn during the last few months, is the Faure battery, in which M. Faure does not form the cells by electrolysis, but coats the lead plates with a film of red lead or minium, enclosing or protecting the red lead coating with a layer of felt. His cells are of large size, and each is therefore capable of storing up a considerable quantity of electrical energy. The chemical action is similar to the action in a Planté cell, but the resistance is higher, and when in use the battery takes longer to discharge itself, so that for electric lighting and for many purposes for which a store of electricity is required, it seems to be better adapted than the Planté cell.

It has been said, and the statement has been confirmed by Sir Wm. Thomson, that a "Faure accumulator, weighing 75 kilograms (165 lbs.), can store and give out again energy to the extent of an hour's work of one horse-power," or two million foot-pounds. At first these cells were made cylindrical, and the Faure Accumulator Company have kindly lent me a box of four such cells in action, similar to the celebrated box of electrical energy, or condensed lightning, so graphically described in the *Times* of May 16th last, which was carried from Paris to Glasgow for examination and measurement by Sir Wm. Thomson. They have also lent me one of their latest forms, in which the plates are flat and placed vertically in the box.

It has been ascertained by Sir Wm. Thomson that Faure's accumulators, amounting in weight to three-quarters of a ton, will continue to work for six hours from one charge, at the uniform rate of one horse-power, and that probably 90 per cent of the energy spent in charging will be transformed into useful work. Very few comparative trials have been made of the Planté and the Faure batteries, but from those which have been made by M. Achard, it appears that, as might be expected, they are equal in electromotive force, that the Planté cell is of smaller resistance than the Faure cell, and consequently will heat a longer piece of platinum wire and do its work three times as rapidly. The Planté cell kept a platinum wire three-tenths m.m. in diameter, and five or six c.m. long, red hot for half an hour, and the Faure cell kept the same wire red hot for an hour and a half. We may readily see by a few experiments that the Faure's battery has collected a great quantity of electrical energy, for one box of it will cause a platinum wire of considerable length, and one m.m. in diameter, to glow, and one cell is sufficient to drive a small dynamo-electric machine as a motor, or to drive a small electric engine, and the three or four cells are sufficient to cause a small Swan's incandescent lamp of small resistance to give out a very pleasant light of about two candles. Those who saw my lecture room and the Wheatstone laboratory at our Jubilee Soirée on July 2nd last, brilliantly lighted during the evening by Swan and Lang Fox incandescent lamps, which were kept in

action by means of Faure's accumulators, will not doubt the possibility of lighting by means of incandescent lamps, nor forget the satisfactory results obtained through the agency of Faure's secondary battery.

There are many applications which have been or may be made of secondary batteries. Six Planté cells have been found sufficient to drive a tricycle with 160 kilograms, or about 350 lbs., upon it, at a rate of ten miles an hour, or to drive a boat containing three persons.

These secondary batteries (1) may be used to carry a supply of electricity where it is wanted. (2) They may accumulate supplies from a dynamo machine and store energy up for electric lighting or for motive power. (3) They may serve as regulators for the electric current, when as in electric lighting it is liable to fluctuations, either from the irregularity of the driving engine or from the change of resistance in the electric arc or in the electric current. When so used, they would supply and keep up the light even though the engine were suddenly to stop, or any accident to happen, other than the cutting of the connecting wires. The Faure's accumulator has been employed to light a railway train from London to Brighton, by means of incandescent lamps, and to work an electric motor so as to drive a circular saw or other mechanical tools. It has also been employed with very satisfactory results in driving a tramway in the streets of Paris, and in the Siemens Electric Railway between the Electrical Exhibition and the Place de la Concorde. The results already attained seem to show that there is no other secondary battery which can compare with this for storing up and keeping for a long time a supply of electric energy, and for using it slowly when in action.

ELECTRIC LIGHTING—ITS FIRE RISKS AND THEIR REMEDIES.

By HENRY MORTON, Ph.D.,
President of the Stevens Institute of Technology.
(Continued from vol. xlii., page 288).

As a means of practically dealing with the above subject it will be perhaps best, in the next place, to review the "requirements" recently recommended to the New York Board of Fire Underwriters by their Committee on Origin of Fires.

The first of these requirements is that all wires used to convey electric currents for lighting purposes should have at least fifty per cent more conductivity than is requisite for the number of lights to be supplied by such wires.

This requirement is a perfectly fair one and in accordance with the general principles set forth in my previous article, but its signification is rather obscure and indefinite; it is also one which is certain to be fulfilled by all those who are engaged in supplying electric light, on economic grounds.

The term "conductivity necessary for the supply of the number of lights used" is, in the first place, obscure, because, in the case of arc lights, run as they always are in successive series, the conductivity necessary for one or for any number of lights is the same. A wire which will carry a current to one arc light will continue to carry it on from this light to the next, and so on to any extent, just as a road which is wide enough to let one cart pass is wide enough for a train of carts, passing one after the other. We may, in fact, regard the successive arcs as like a series of cascades on the same stream, down which the same water runs from one to the other, and where manifestly no more is required to supply the whole series than to supply any one of the successive falls.

This consideration, therefore, manifestly contemplates only incandescent lights where the number of lights will determine the quantity of the current needed to supply them, because they are always connected in parallel series,

and the portion of the current which traverses one lamp traverses no other, but returns to the generating machine by the conductor.

In this connection another point should be noticed. In the machines used for producing arc lights the armatures of the machines are wound with a wire very much smaller than that which it is economical to use in any other part of the circuit. If, therefore, a current was produced sufficient to develop heat in the circuit, it would develop much more in these armature coils than anywhere else. In fact, in the ordinary running of such machines these coils become quite hot, even when no sensible heat whatever is developed in the line wires, and it is manifest that long before the line wires could become dangerously heated the wires of the armature would be melted and the machine destroyed. Nor is there any danger that these proportions will ever be changed by those using such apparatus. Every unit of heat produced in the conducting wires is a dead loss of power, and to have the conducting wires of a circuit so small that they would get as hot as boiling water even, would double or treble the cost of operating the system, or make it, in fact, not profitable, but ruinous to those interested.

Although, in the machines used for the incandescent light, the armature is often made of bars of copper, and would not be heated to destruction by a current which would heat the conductor to a dangerous degree; yet the question of economy is equally important in this case also, and those supplying such lights will be sure in their own interests to use conductors of abundant capacity.

The first requirement may then be regarded as one which, however defective in expression, is right in intention, and will be readily complied with by all those supplying or using electricity as a source of light.

The second requirement is that all conductors should be insulated and doubly coated with some approved material.

This requirement is also reasonable and fair in spirit, though faulty in expression.

Thus "a double coating," of course, means nothing as regards efficiency, since two thin coatings might be inefficient where one thick coating was thoroughly effective, and it is manifest that no one material should be exclusively selected. Any insulating material which is a good insulator and, at the same time, has such mechanical properties as will secure its maintaining its position on the wire under normal conditions of wear, or any combination of materials securing like results, would of course meet the actual requirements of the case. In applying this regulation, moreover, it must be remembered that the coating is not to be regarded as a sort of armour to keep in some explosive fluid which is endeavouring to escape, but is rather a "fender" to prevent contact of the wire with other conductors, and that no harm can come as long as such contact is prevented.

The third requirement is stated as follows:

"All wires are to be securely fastened by some approved non-conducting fastening, and are to be placed at least 2½ inches from each other for incandescent lights and 8 inches apart for arc lights, and 8 inches from all other wires, and from all other metal or conducting substances, and to be placed in such a manner as to be thoroughly and easily inspected by surveyors."

These requirements literally construed would be impossible to fulfil in many cases, and in others would increase in place of diminishing the risks which they propose to obviate.

Thus, while, as a general rule, it is best to keep the outgoing and return wires as far apart as possible, this would manifestly be next to impossible where they approach the lamps, and, in such cases, would be utterly useless.

Thus, for example, the two wires twisted together as a cable, and inclosed in a strong metal tube, would be in the safest possible condition in many cases, as well as the most convenient where a cluster of lights or a single light was arranged in a chandelier, or the like fixture. Again, the wire being properly covered with an insulating

envelope would be much more secure if attached by strong metal fastenings than if held by insulating fastenings liable to break or yield.

Again, in an iron building it would be manifestly all but impossible to keep the wires 8 or even 2½ inches from all metal or like conductors, and any such arrangement would be equally needless, if not, in fact, injurious.

The real security would be insured by so arranging the wires that all contact with the metallic or other conductors would be impossible, and then the insulated wire would be in its safest condition, if actually inclosed in the conducting substance out of reach and sight.

This third requirement will manifestly need radical modification before it can become effective in any way.

The fourth requirement is that all lamps should be protected by globes, so as to prevent the falling of sparks or particles of heated carbon or metal.

This requirement is obviously proper, and needs no comment.

I should here, however, remark that, in addition, some automatic device for throwing off the current if an excessive arc is formed, as mentioned in my previous article, would be necessary to make this requirement in all cases effective in securing its object, as otherwise so violent an action might take place that even the globe might fail to protect.

The fifth requirement calls for a means of shutting off the current from the outside, where wires enter a building from outside.

This is manifestly proper, just as it is in the case of an illuminating gas.

Another requirement which should be added is the insulation of the dynamo-electric machines from the ground. This would largely diminish the risks from contact with conductors and other wires, because two contacts with the electric circuit would then be necessary to secure the passage of the current through the accidental conductor. —*The Sanitary Engineer*, December 15, 1881.

NOTE ON A COMPOUND OF QUININE AND QUINIDINE.

By C. H. WOOD and E. L. BARRET.

THE discovery of a new alkaloid, closely resembling quinine, is that description of *Cinchona* bark known in commerce as "Cuprea bark," recently made by D. Howard and J. Hodgkin, and almost simultaneously announced by B. H. Paul and A. G. Cownley, and by W. G. Whiffen, will doubtless attract much attention. As these chemists all describe this newly discovered alkaloid as chiefly remarkable for its property of crystallising from an ethereal solution, it may be of interest to briefly refer to a peculiar crystalline body which we also first became acquainted with in working on samples of these Cuprea barks.

When Cuprea bark first came into the market, we noticed that an ethereal solution of the total alkaloids extracted from it would frequently furnish a notable quantity of crystals that did not resemble those of any of the known *Cinchona* alkaloids obtained under like circumstances. As the analysis of the total alkaloids, however, had not revealed the presence of any distinctive base, and as the Cupreas are chiefly remarkable for yielding an unusually large quantity of quinidine,* it seemed probable that these crystals were a compound of the quinine with the quinidine. We, therefore, took two grains of the pure quinine and one grain of the pure quinidine, both yielded by the bark, and dissolved them together in ether. The solution furnished an abundant crop of the same crystals. These crystals, when collected, washed with ether, and converted into neutral sulphate, furnished a quantity of

* We have met with several samples yielding over 1 per cent. of crystallised sulphate of quinidine.

pure sulphate of quinine, and the mother-liquor from which the sulphate had been separated yielded a like quantity of quinidine.

The quinine and quinidine used in the experiment had been carefully tested, they had each given the correct angle of rotation to a ray of polarised light, the one to the left and the other to the right, and the quinine had remained dissolved in ether for some weeks without furnishing a trace of crystallisation.

To satisfy ourselves that the power of forming this crystalline compound was not peculiar to the quinine and quinidine yielded by *Cuprea* barks, we took some pure quinine prepared by ourselves from South American yellow bark, and also some quinine made in India from the *Calisaya* grown in Sikkim. We fortunately possessed some pure quinidine that had been purchased from an eminent maker some time before *Cuprea* barks came into commerce. Either of these quinines dissolved with the quinidine in ether furnished a crystalline compound identical in all respects with that just described. There could be no doubt, therefore, that ordinary quinine and quinidine possess the power of combining together to form a crystalline compound very sparingly soluble in ether; also that the compound is easily separated into its constituents by converting it into neutral sulphate, when the quinine sulphate crystallises out by its greater insolubility, the quinidine sulphate remaining in solution.

Perhaps the easiest way of obtaining this compound is to dissolve one part of pure quinine in 30 or 40 of ether, and add to the liquid a saturated ethereal solution of a like quantity of pure quinidine. Upon mixing, a crystalline precipitate of the body forms in abundance. Its solubility in ether is much less than that of either of its constituents, 100 c.c. of ether at common temperatures only dissolving 0.5 grm. of it.

It is more soluble, however, in ethereal solutions of quinine or of the amorphous alkaloids, and these solutions frequently exhibit supersaturation very well, remaining clear for some hours and then suddenly giving an abundant crystallisation. The compound, when isolated, may be re-crystallised from ether, apparently without change. Our results up to the present moment indicate that it contains the quinine and quinidine in equal proportions. Pressure of other work had much retarded us in the study of this compound, and the announcement of the newly-discovered alkaloid by the chemists above-named took us somewhat by surprise. We at once commenced the examination of all the alkaloid products we have accumulated from several hundred samples of *Cuprea* bark in the hope of getting some of the new base, but as yet our attempts have been unsuccessful. We have thought it best, therefore, to publish our results thus far, and reserve further particulars for a future communication.

ON THE
ACTION OF WATER UPON LEAD PIPES,
BEING A
TRANSLATION FROM THE FRENCH OF M. BELGRAND,
WITH INTRODUCTORY REMARKS BY

W. SEDGWICK SAUNDERS, M.D., F.S.A.,
Medical Officer of Health and Public Analyst for the City of London,
Late President of the Hunterian Society, &c.

TO THE HONOURABLE THE COMMISSIONERS OF SEWERS
OF THE CITY OF LONDON.

GENTLEMEN,—Agreeably to the instructions of your Honourable Court, dated the 27th of September last, I present to you the following translation of the essay of M. Belgrand on the action of water on lead pipes.

In rendering the same into English I have endeavoured to convey the information it contains without strictly

adhering to the exact verbiage of the author, a course found necessary owing to the many technicalities with which it abounds, and for which I have been unable to find a literal equivalent; whilst it is, however, a perfectly free translation, the scientific details dealt with have been scrupulously reproduced.

The action of waters upon lead had been long recognised by chemists of all countries, and before the appearance of M. Belgrand's brochure much had been written upon the subject, and the chemical conclusions enunciated by him anticipated by a general consensus of scientific opinion.

The purest waters, when in contact with air, seem to produce the speediest effects, but no change is observable when lead is brought into relation with *pure* water from which the air has been expelled by boiling:—a powerful corrosive action goes on when the metal is exposed to the combined action of air and *pure* water. "The surface of the lead then becomes oxidised, the water dissolves the oxide, and this solution absorbs carbonic acid, when a film of hydrated carbonate of lead is deposited in silky scales. Another portion of oxide is formed, which is dissolved by the water, and thus a rapid corrosion of the metal ensues. This action is materially modified when various salts exist in the water, and even when their quantity does not exceed 3 or 4 grains in the gallon. The corrosion is increased by the presence of chlorides and nitrates, but diminished by sulphates, phosphates, and carbonates, the oxide of lead being scarcely soluble in water containing these salts in solution."—Prof. MILLER.

Water is said to have less effect upon lead when the metal is bright and new than when it has become tarnished by exposure to the atmosphere, but in either case the action is much more rapid with pure waters than with those containing foreign matters, salts, &c.

Many waters containing organic matter act upon lead, and it is probable that to this fact the well-known corrosive effect of alluvial deposits is due, when under these circumstances the metal becomes covered with a compact film of sub-oxide, which protects it from further injury.

Great divergence will be found in the writings of authors entitled to respect concerning the action on lead of waters containing free carbonic acid; thus, Miller, Graham, Frankland, Hofmann, and others, from whose works these introductory remarks are chiefly compiled, contend that carbonic acid protects the lead by forming with the lime salts existing in most waters an insoluble crust of carbonate of lead in the pipe, whereas M. Langlois* attributes a great action on lead to the carbonic acid, but admits that carbonate of lead counteracts its effects.

Prof. Parkes, however, reminds us that an excess of carbonic acid may dissolve this coating, since we know that water charged with this gas under pressure, as in aerated waters, will rapidly absorb lead, a fact which at once explains the occasional mischief produced by the incautious employment of leaden and composition pipes in the manufacture of artificial mineral waters and effervescing beverages.

Other substances in water, such as the organic acids of vegetables and fruit, and even sour milk, may have the same effect.

It has been authoritatively laid down, that "the presence of dissolved oxygen, and the absence of more than three volumes of carbonic acid in 100 volumes of water, are amongst the conditions necessary for the attack upon lead."—*Rivers Commission*, 1851.

Some waters contain lead as a natural constituent; the supply to the town of Edinburgh, for instance, is said to be contaminated to the extent of 1-140th of a grain to a gallon, a proportion which does not appear hurtful. Calvert found that from 1-10th to 3-10ths of a grain per gallon existed in some water at Manchester, and was the cause of much suffering. Again I may mention the well-known cases of poisoning amongst members of the ex-Royal Family of France, at Claremont, where 34 per cent

* M. Langlois, "Rec. de Mem. de Med. Mil." 1865.

of those who drank the water were affected by 7-10ths of a grain per gallon. In my own practice I have invariably condemned water in which lead existed to the extent of 1-10th of a grain per gallon, and believe it would be safer to reject a sample containing even half this quantity, having regard to the fact that some persons are much more susceptible to its injurious effects than others.

In 1877, Mr. G. Bischof called attention to the fact that lead piping frequently contains antimony, which adds sensibly to the danger of its use; the same chemist also adverts to the reprehensible practice of plumbers using composition tubing in connection with water supplies for domestic purposes.

In substitution for lead I know of nothing better than wrought-iron pipes leading from slate or galvanised iron cisterns, where a constant service cannot be obtained.

In H. M. Navy the water tanks are not galvanised, but the interiors are occasionally lime-washed, it having been found that with galvanised pipes the water becomes impregnated with zinc, which may be seen as a white film floating on the surface.

It is true that water in passing through iron pipes becomes turbid by the presence of yellowish suspended matter, which is in fact a hydrated oxide of iron or rust, but this is not injurious to health and is at once removed by ordinary filtration.

Hard waters act less upon iron than soft waters. The Sixth Report of the Rivers Pollution Commission, 1874, pp. 221-222, contains some very valuable information respecting the best methods of protecting cast-iron pipes from corrosion.

I object to the lining of one metal with another, such as tin upon lead, as proposed by M. Belgrand, for two reasons, first, because when different metals are brought into contact a galvanic action is set up; second, because block tin pipes have been known to be eaten through by water in consequence of the presence of nitrates (De CHAUMONT).—I have the honour to be, Gentlemen, your obedient Servant,

W. SEDGWICK SAUNDERS.

13, Queen Street, Cheapside,
October 30, 1881.

THE ACTION OF WATER UPON LEAD PIPES.*

LEAD has been employed in the manufacture of conduit pipes ever since the distribution of water in towns was first established by the Romans, the first aqueduct, the Appian, according to Varro,† being constructed in the year of Rome 442.

From that period leaden pipes have been in constant use, all the water services in the interior of ancient towns being made of that metal.

Each consumer had his branch connected with the reservoir or basin of distribution common to all the inhabitants of a district, and leading to his dwelling.

The public fountains were supplied in the same manner. The pipes which united the private to the public water works were invariably made of lead. (See Frontin,‡ who gives dimensions of the leaden pipes laid down in Rome.)

This mode of circulation necessitated very long leaden water pipes, and was used in Paris until within the last few years; it still exists in Rome, at Claremont-Ferrand, and in several other towns.

In the middle ages, and until the end of the 18th century, public supply pipes were made of lead, and many of this material were found in Paris some years since, dating from the time of Philip Augustus.

The employment of cast pipes became general about 1782, at the time of the establishment of Chaillot's works

and of the Gros-Caillois, by the Brothers Perier. From those remote times up to that period no danger whatever had been discovered in the use of lead. Neither Pliny, Frontin, nor any of the old historians, ever pointed out the slightest injurious effect traceable to it. It was the same in the middle ages and in modern times.

Only within the last few years an attempt has been made to alarm the public by endeavouring to show that the use of lead pipes is dangerous; the water, it is said, is impregnated with a small quantity of lead, which creates a slow, but pernicious, action upon the health of the consumer. This year the war against lead ("*La guerre au Plomb*"), the name given to this crusade, has made great development and caused considerable uneasiness in the minds of Parisians.

It became, therefore, my duty to examine what foundation existed for these charges, and I have done so with the help of M. Felix Le Blanc, a distinguished chemist and gas-examiner. M. Boudet was entrusted with a similar investigation for the Board of Health.

I must first clearly state the case and give the facts concerning the distribution of water, both public and private, in this city. The following statistics, dated 31st March, 1872, relate to the public services, viz:—

Cast iron pipes	1,333,184 metres.
Tarred sheet iron pipes ..	63,126 "
Lead pipes (about)	3,000 "
Total	1,399,310 "

It is thus apparent that the main pipes are out of the question, and that "*La guerre au plomb*" would be objectless if there not also existed a network of short connecting pipes of very small diameter, and which, almost without exception, are made of lead.

These small pipes connect the main pipes with the draw taps; their network may be sub-divided thus:—

1. Pipes connecting the Public Buildings 152	
2. Do. the Circuit	14
3. Pipes connecting the Municipal Buildings:—	
*Water Posts, "à repoussoir"	224
Draw Wells	33
Street Fountains	456
Hired Fountains	26
Bureaux de Stationnement	155
Various Municipal Establishments ..	167
Religious Buildings	49
Schools and Colleges	247
	1357
4. Charitable Institutions	83
5. Private Houses of Subscribers to the	
Town Supply	37,889
Total	39,495

Most of the leaden pipes, therefore, are chiefly employed to connect private houses with the main supply pipes.

In the foregoing calculation, those municipal supplies are omitted which are never used for drinking purposes, for example, monumental fountains, flushing pipes under the footways, corner posts, watering jets, fire plugs, steam pumps, and urinals, 8277 in number, nor for watering the streets or the garden, which are not less numerous.

The leaden branch-pipes connecting dwelling houses with the main supply number about 39,500, and their average length may be put at 40 metres,† and their total length at 1,580,000 metres.

In spite of the great complexity of this network, every drop of water drawn for domestic use runs through a very small length of lead pipe, say 5 metres when drawn from the standpipes in the street, or at most 100 metres when taken in a private house.

In the case of houses that are occupied, the longest

* Pressure fountains or ordinary pumps with handles.—W.S.S.
† A metre is 39·363 inches English.—W.S.S.

* Paper by M. Belgrand in the *Transactions of the Academy of Science*, vol. lxxvii., November, 1873.

† Varro, *Marcus Terentius*, a learned writer at Rome, B.C. 116.—W.S.S.

‡ Frontinus, *Sextus Julius*, a Roman statesman and author, in the latter half of the first century, wrote a treatise "*De Aqueductis*," still extant.—W.S.S.

period for the water to remain in the leaden pipes can be estimated thus:—

Houses having unlimited { 0 hours during the night.
supply { From 5 to 10 mins. during day.
Gauged supply { from 3 to 6 hours at the most.

As will be seen further on, the time the water is in contact with the interior surface of the pipe is too short for the lead to be attacked.

I have already stated that in the network of main pipes there are about 3 kilometres* of lead piping. These are from time to time removed, and on examination their interior surfaces are invariably found to be perfectly smooth and without any trace of corrosion.

I now exhibit two pieces to the Academy; one comes from the service pipe of the Faubourg Saint Antoine, laid down in 1670, at the time when the pump of the Bridge of Notre Dame was erected; it is therefore more than 200 years old, and in the interior the impression of grains of sand is still to be seen; the other was taken up from a side street of Saint-Germain Market; it is somewhat less old, but equally unblemished.

It may be added that the leaden pipes become firmly and rapidly coated with a thin crust† which prevents the water coming in contact with the lead. I place before the Academy for inspection a piece of pipe upon which this is distinctly seen. I visited at the factory of M. Fortin Herrmann, contractor for public works, the depot for old and disused lead pipes, where numerous fragments of these branches are to be found, and did not find one piece in it which was not in this condition: the internal surface of the lead being perfectly smooth, and covered by a thin very adherent coating of carbonate of lime.

The harmlessness of leaden pipes appear to me proved by these facts, which explain why they are in use in all the towns of France, and in most European cities, without ever having given cause for complaint.

I have, however, by direct analysis, sought for lead in all waters with which Paris is supplied, and in these analyses M. Le Blanc was good enough to lend me his valuable aid. The experiments were first made upon the public waters of Paris drawn at the following points:—

1. Seine water at the Hôtel Dieu, from a lead branch 200 metres long.
2. Seine water at No. 74, Avenue d'Orleans, lead branch of 100 metres long.
3. D'Ourcy water at the Hospital des Recollets, pipe 130 metres long.
4. Dhuis water at No. 40, Avenue de Clichy, pipe 20 metres long, consumption of water per diem 250 litres.
5. Dhuis water at No. 25, Rue de Moscow, lead pipe 40 metres long.

A sample bottle of 5 litres of each kind was sent to M. Le Blanc, who reported;—

"Sample received 16th August, 1873. Not any of these clear and colourless waters give an appreciable colouration with sulphuretted hydrogen; not a trace of lead is found in the residue obtained by evaporation in a platinum capsule. The same remarks apply to the sample received on September 1st, and to that of October 1st.

It must be concluded from this first series of experiments that the public waters of Paris, drawn at the extremity of the leaden branches, do not contain a trace of the metal when the house is inhabited, that is to say, when the water does not remain in the pipes more than nine or ten hours.

M. Le Blanc has undertaken other experiments, by leaving the lead in water for a much longer period. I quote his own words:—

On the Action of Waters Upon Lead.

Chemists have long known with what facility lead becomes oxidised when immersed in distilled water in con-

tact with air. Very small white shiny crystals of the hydrated oxide of lead are very rapidly formed, their quantity augmenting until a copious sediment at the bottom of the vessel has formed; the same obtains with pure rain-water.

On the contrary, water containing a given quantity of salts, principally from selenitic wells, does not attack the lead under the same conditions at all.

Such are the results of experiments made by Professors of Chemistry during the last forty years in public lectures, and M. Dumas never omitted to place them before his class at the Sorbonne.

Chemists have often remarked upon the harmlessness of lead with regard to potable waters, circulating in pipes of this metal, because of the saline matters which preserve the metal from oxidation.

No doubt it would be difficult to give an explanation of these facts, but they seem of the same kind as those which have been established with regard to iron, which can be preserved without oxidation in distilled water, even when aerated, if only a few drops of an alkali be added to it, whilst it is oxidised rapidly in pure aerated water. But it is curious to observe that by augmenting to a certain extent the proportion of alkali, oxidation can be facilitated.

It is well known how much the peculiarities pointed out by M. Gaynard in the case of the water pipes at Grenoble, have occupied chemists during the last forty years.

It becomes therefore of importance to ascertain whether the purest potable waters contain sufficient saline matter to preserve the lead from oxidation.

The following table shows that very pure water, such as from the wells of Grenelle, possessing much less saline matter than water from the Seine, has yet the power of preserving the lead from oxidation. The water in question shows from eight to ten degrees of hardness.

It will be seen that the waters marking even less than one degree of hardness still preserve this same quality. Indeed, rain water itself cannot attack lead, if it has not been collected with the greatest care, and after prolonged washing by the atmosphere by previous rain. However little rain water may indicate by reagents the presence of the salts of lime, we find that it does not act sensibly upon lead. When rain water does not give any reaction with lime reagents, it rapidly commences to attack the lead in the same way as distilled water does.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY

General Meeting, October 27, 1881.

Mr. J. W. SWAN, President, in the Chair.

THE minutes of the last meeting were read and confirmed.

The Treasurer's statement was presented.

The Committee's report was then read.

Mr. SWAN—I had intended, as the notice of the meeting states, to make a communication to-night on the subject of "Voltaic Accumulation;" but since I spoke to our Secretary on the subject, my time has been so much occupied in connection with the Exhibition in Paris, that I had either to bring the subject before you in a very incomplete state, or to postpone it till a later date. I have chosen the latter course. I intend at the December meeting to read the paper which I had purposed reading to-night; and as the Paris Electrical Exhibition was the cause of my shortcoming, I will make amends to some extent by giving you to-night a short account of it drawn from my personal recollections.

The Exhibition, as you know, is an International Exhibition of objects of interest in connection with electricity,

* A kilometre is 1000 metres.—W.S.S.

† Carbonate of lime.—W.S.S.

both in its scientific and practical aspect. It is held in the Palais de l'Industrie, a building of a permanent kind standing in the Champs Elysées, stone walled, glass roofed, and in general arrangement like other International Industrial Exhibition buildings. It is very large, and one of the feelings that the sight of it excites is wonder that a science so young as electricity should have already given birth to such a multitude of objects not only scientifically interesting, but useful in every-day life, as are required to fill this immense building, and with which it actually is filled.

One-half of the Exhibition is occupied by the exhibits of France, and the other half by the exhibits of other nations. Of these, Belgium, Germany, England, and America are chief, both in the number and importance of the objects exhibited.

As you approach the Exhibition at night, you can see from a great distance the sky above it lit up by the silvery light which streams upward through the roof, and illuminates in the most wonderful way mist and smoke, and shows with extraordinary distinctness all the movements of the air currents in the neighbourhood of the building, giving them an appearance of whirling clouds of smoke. Besides this welling up of light through the roof, two great beams of 50,000 candle power stream from it horizontally as from a great lighthouse; you have, therefore, no difficulty in discovering, even in the darkest night, the whereabouts of the Exhibition.

Further help is afforded by the electric railway which you meet on your way to the Exhibition. The station is brilliantly lighted by electric lamps, and you enter a tram-car very like an ordinary tramcar in appearance. The force which propels it is supplied by a dynamo-electric machine, fixed at one end of the line. The electric current from this stationary dynamo is conveyed (by sliding conductors running in overhead slit brass tubes, and connected with the car) to a second dynamo placed under the floor of the car, and connected with its driving wheels by a chain band. The toot of a horn, the turn of a handle, and in two minutes, without either smoke or noise, you are landed in the electrical fairyland. You are attracted first by the brilliancy of the illumination as you enter the building. The blaze of light in contrast with the darkness outside is overwhelming. Hundreds of electric lamps hung from the roof, planted on the tops of tall posts and placed on every coign of vantage, contribute to the dazzling effect. There is a tremendous din of machinery at this point, because it is near where the numerous steam engines and gas engines are placed which drive the still more numerous dynamo-electric and magneto-electric machines. There are as many as sixteen dynamo-electric machines driven by one gas engine—a pair of coupled cylinders of 50-horse power—working most beautifully. Gas engines of every size abound, most of them driving dynamos, but the heavy work is done by the steam engines, of which there is a great variety, and many splendid specimens of mechanical work. Conspicuous by their number among the dynamos are of course the Gramme machines. I suppose there are hundreds of Gramme-dynamos working, many of them most beautifully grouped for compact and convenient driving, and employed chiefly to work lamps and some other dynamos for obtaining motive power. All the makes of dynamo-electric machines are represented, most of them very largely. Siemens's apparatus is here, there, and everywhere. There is a grand array of Brush machines, and among these two capable of supporting forty lamps in series, having probably an electro-motive force of nearly 2000 volts—that is, a tension equal to that which would be produced by 1000 Grove cells. There are a great number of magneto-electric machines of an improved type constructed by De Meritens, much used for lighthouses. There are several unusual forms of dynamo, such as the Bûrgen machine, the Culcheth machine, and a Swedish machine in which the stationary magnet is inside as well as outside the armature; but the most unique machine,

not from difference of principle, because they are all alike in principle, but from its unusual appearance and its great size, is the Edison machine. This machine is probably the largest dynamo-electric machine ever yet made. Its armature weighs nearly three tons, and is geared directly to the axle of the steam engine which drives it—an Allen-Porter engine of 100-horse power, and making about 350 revolutions of the crank per minute. Usually, as you know, the armature of the dynamo is small in diameter, and in order to obtain the necessary surface speed for the development of sufficient tension in the current produced, a great speed of rotation is necessitated, and to obtain this belts have to be employed at a sacrifice both of power and safety. Clearly the right thing in the development of the dynamo is to make the armature of large diameter—why not the fly-wheel itself, and of a like diameter?—and then a comparatively slow rotation, such as can be obtained directly from the crank axle of the engine when going at a moderate speed, will give all the necessary surface speed for the armature thus expanded.

Engines driven by electricity occupy an extremely important position in the Exhibition. There are numerous small machines, such as sewing machines, driven by Depretz motors, fed by the currents from Gramme machines. As this motor gives a speed of several thousand revolutions per minute to the pulley attached to the armature, it is extremely convenient where high speed is wanted.

Among moving mechanism of a light kind there are electric clocks without end, both to work independently and to govern other clocks. The jingle of clocks and chimes worked electrically is perpetually on one's ear. I need hardly say that the clocks are worked by voltaic cells, for the most part by the Leclanché cell, than which nothing that I saw at the Exhibition does better for such purposes, where short spasmodic action with intervals of rest is required, and where durable effectiveness is necessary.

But the most striking novelty among machines is not the numerous sewing machines and clocks and other machines of a light description driven by electricity, but the heavy machinery—the railway cars, the electric plough, the planing machines, the lathes, the looms, the rock drills, the pumps throwing out a perfect torrent of crimson water, the punching machines, the hammers, and a multitude of other large machines. The way in which these ponderous machines move by invisible agency as though by magic, strikes one as very remarkable, and as foreshadowing a great future for electro-motive engines.

In the matter of telegraphic apparatus it is quite clear that we were by no means behind our neighbours. The English telegraphic exhibits were decidedly the finest in the place. In France they use Hughes's printing telegraph, which is not operated so quickly as the Wheatstone and Morse instruments in use on the English lines. When we come to telephones, however, the French, judging from the examples which come under one's notice at the Exhibition, are very much ahead of us. The telephones which one has been in the habit of hearing in England, and these which are to be heard at the Exhibition, bear very much the same relation to one another that moonlight does to day-light. Listening to the telephones in communication with the Opera House, the strength, the clearness, and distinctness with which every sound on the stage was heard is quite wonderful. For that interesting experiment the transmitting instruments are placed on the stage of the Opera House, six on one side and five on the other side of the prompter's box, and a pair of Ader telephones is connected with each transmitter.

One had fancied that it would be a difficult thing to construct a telephone which should not depend on the principle of electro-magnetic induction which is at the bottom of the action of the Bell telephone, but in the Exhibition there are two kinds of telephone, working upon quite a different principle: these are Edison's loud speaking telephone, and Dolbear's telephone.

In the Dolbear's telephone the vibration of the disc which emits the articulate sound is produced not by electro-magnetic attractions, but by purely electrical attraction, such as operates in the case of the pith ball electrometer.

As in almost all the various telephonic arrangements, a carbon microphone is employed as the transmitter at the sending end of the line. In circuit with the microphone are placed some voltaic cells, and in the same circuit, but at the receiving end of the line, is an induction coil, consisting of a primary helix of thick wire, and a secondary helix of thin wire, superposed on the primary helix, but not in circuit with it. The terminals of the secondary coil are connected by flexible wires with thin discs of metal placed a small fraction of an inch apart, and face to face. These discs are mounted in wood blocks, suitably shaped for holding up to the ear.

That being the arrangement, it is evident, that so long as the microphone is undisturbed by sound waves, a uniform current will circulate in the primary helix of the induction coil, which includes in its circuit the voltaic cells and microphone; there will be no electrical disturbance induced in the secondary helix, but the instant the carbon of the microphone transmitter is disturbed by sound, the fluctuations of current in the primary helix which ensue upon the disturbance taking place, are followed by corresponding fluctuations of electric condition in the secondary helix: no current passes because it is not a closed circuit—the air space between the discs interrupting it; but a state similar to that which subsists between the two coatings of a charged Leyden jar is induced in the opposing sound discs, which represent the two terminals of the secondary coil; these vibrate under the influence of varying attraction for each other corresponding with the variations in the flow of current in the primary coil, and exactly as the iron plate of the Bell telephone vibrates under the influence of a varying magnetic attraction.

But the climax of ingenuity is reached in Edison's telephone, which is on a totally different principle from either, in so far as the speaking part of the instrument is concerned, but I fear there is not time to go so much into detail as I am doing, I will therefore not describe it.

In the English Post Office Pavilion the oldest and the newest forms of telegraph instruments are to be seen, and much besides that is noteworthy. It is rich in objects of historical interest in telegraphy. The very youngest ideas in the erection, the submergence, and insulation of telegraph wires are there exemplified by models or specimens of the ancient styles. Worthy of notice are the tangled masses of submarine cable, dragged up from the bottom of the sea after long submergence; among these, some of the first Atlantic cable, twisted and contorted in the most fantastic and almost unrecognisable shapes. But it is impossible to dwell on details; had time permitted I should have taken you to the Belgian Department, and shown you a wonderful piece of electrical mechanism for the automatic registration of meteorological change, an apparatus which registers in a tabular form, and even automatically engraves every ten minutes, the height of the barometer, the temperature of the wet bulb and the dry—the force of the wind and its direction, and the rainfall; the action of the registering mechanism of all these different instruments is controlled by a single electric wire. It is a marvel of ingenuity and mechanical skill.

I should much have liked to have taken you to the Norwegian corner of the Exhibition, where is shown a collection of most ingenious apparatus, which, by means of vibrating balls and pulsating diaphragms submerged in water, illustrates, in a wonderful way, electrical and magnetic attractions and repulsions, the difference between attractions and repulsions being determined by the synchronism or non-synchronism of the pulsations of the diaphragm or the vibration of the ball.

It would have been interesting to have looked at the Paccinotti ring, the primitive pile, and other apparatus used by Volta—the bundle of bars of bismuth and anti-

mony built up by the hands of Melloni—at the table covered by movable wire spirals and rectangles which belonged to Ampère, and by means of which he demonstrated the attractions and repulsions of electric currents—at the wooden trough which Davy employed in effecting the decomposition of potash—at the coils and magnets which aided Faraday in producing an electric spark from magnetism, at the first bridges constructed by Wheatstone, at the original cells of Daniell, at the measuring instruments of Ohm, and at a great mass of other apparatus identified with the researches of Biot, of Arago, of Oersted, of Becquerel, and the whole host of worthies whose names are for ever enrolled in the annals of electrical discovery.

But much of interest as there is to be seen besides what I have mentioned, it is too late to extend our observations, and therefore, with whatever regret, we must perforce say good-bye to this, the latest and greatest of Industrial Exhibitions.

NOTICES OF BOOKS.

A Manual of Sugar Analysis, including the Applications in general of Analytical Methods to the Sugar Industry. With an Introduction on the Chemistry of Cane-Sugar, Dextrose, Levulose, and Milk-Sugar. By J. H. TUCKER, Ph.D. New York: D. Van Nostrand.

It is a remarkable fact that extensive as are the interests connected with sugar, and frequent, or rather constant, as are the applications of chemical science which they require, there existed hitherto no work in the English language dealing systematically with this branch of chemical analysis. Our apathy on the subject is the more remarkable when it is considered that we are far greater sugar-consumers than any other European country, and that the British Empire alone is probably able to supply more sugar than any other state in the world. France, Germany, and Austria, on the other hand, have been as active as we have been remiss; and thanks to their energy and perseverance, beet-root sugar, one of the weapons devised against us by the first Napoleon, has become a formidable rival to the true cane-sugar. We say "true" because, although analysis has hitherto not succeeded in showing any distinction between the saccharose of the cane and that of the beet, many persons can distinguish the two by the taste. Bees, we understand, where they have the choice, will crowd to cane-sugar and leave beet-sugar untouched, and a suspicion is gradually gaining ground that the physiological action of these two sugars is not identical.

The author sets out with a summary of the chemistry of the sugars as a class, and then gives a more especial description of saccharose, to which he devotes an entire chapter, of dextrose, levulose, and invert sugar, and of lactose. We venture here to propound a question: Starch, it is said, in any of its forms, when taken as food, cannot be digested until converted into sugar. Why, then, are the physiological actions of starch and of sugar so different?

Dr. Tucker proceeds in the next chapter to the determination of the specific gravity of solutions of sugars. It is somewhat remarkable that he omits all mention of Twaddle's hydrometer whilst speaking at length of the very inferior instrument of Baumé, which has been so justly denounced by Professor Boileau. In the chapter on the determination of cane-sugar by optical methods, he describes the saccharimeters of Mitscherlich, Soleil-Duboscq, and Soleil-Ventzke, Wild's polaristobrometer, the "shadow saccharimeters" of Duboscq and Schmidt and Haensch, and the method of Clerget, with the accompanying table. He states in a note that this process

(Clerget's) is entirely inapplicable when any optically active body is present besides cane sugar or invert sugar, and also if the invert sugar itself exists in an inactive condition as regards polarised light. To this criticism we cannot subscribe.

The chemical methods for the determination of cane-sugar next follow. The process of Peligot is not regarded as very accurate; extraction by alcohol gives good results where the quantities to be dealt with are but small. The fermentation process is justly pronounced "open to many objections." The processes for the analysis of raw sugars and syrups are the best known, and they are ably and clearly described. Still, we fear that they will under very possible circumstances prove unsatisfactory in practice. Further research is needed before the analyst can find himself in possession of methods suitable for every possible mixture of a class of bodies so nearly related in composition and not marked by any very striking reactions. An important section is devoted to the detection of two modern and increasing frauds—the addition of dextrin and of starch, or corn-sugar, to raw or refined sugars. Dextrin is added to raw sugars to give them a higher polarisation: 0.40 per cent of dextrin raises the optical standard 1 per cent. For its qualitative detection the author adds to a concentrated solution of the sample alcohol at 95 per cent. A white, thread-like coagulum shows the presence of the adulteration. Unfortunately, calcium sulphate gives a similar result. Iodised potassium iodide gives a vinous red, or violet colour, with some samples of dextrin, but not with all.

Starch or corn-sugar is now, at least in America, added in large proportions to sugar, syrups, preserved fruits, &c., and goes under the euphemistic name of "new process sugar." Its price is unfortunately very low—about 3d. per lb.—so as to leave a large margin for the unscrupulous. We may here remark that, according to the experiments of Professor Nessler, this substance is decidedly unwholesome. The author admits that there is no accurate method for the quantitative determination of this adulterant. Its presence may be qualitatively detected by attending to the three following points:—Sugars mixed with corn-glucose on solution in water leave white particles of the glucose undissolved. If a sugar adulterated in this manner is examined with the polariscope, the reading does not remain constant, but gradually becomes less. A refined sugar mixed with starch-sugar will show too high a percentage by the saccharimeter, so that the results appear more than 100 per cent. Two chapters are devoted to animal charcoal. Amongst the synonyms of this substance the author omits the name "spodium," which it commonly bears in Germany. The following passage deserves especial notice:—"There has been a method proposed in France for the estimation of cane-sugar in raw sugars, known as the *four-fifths method*, and is, I believe, used to some extent in commercial analysis. It consists in taking four-fifths of the ash as the number expressing organic matter not sugar. The sum of this—the ash, water, and glucose—subtracted from 100 represents the cane-sugar. The method is not worth mentioning, except as a curious example of the aberrations to which the human mind is subject." This process outdoes even the so-called "commercial method" of determining phosphoric acid in coprolites, superphosphates, &c., viz., by adding ammonia and accounting for the entire precipitate as tricalcic phosphate!

Dr. Tucker's work is well illustrated, and in case of some of the less common instruments described and figured, the address of the maker is given in a footnote. The getting-up of the book is excellent, with, perhaps, the exception of the index and of certain tables, which are in an uncomfortably small type. The work decidedly supplies a want which must long have been felt, and it places in the hands of the profession information which must otherwise be sought up, at great outlay of time, in the foreign journals.

CORRESPONDENCE.

WASH-BOTTLE.

To the Editor of the Chemical News.

SIR,—Since the appearance of Mr. M. H. Foye's letter in the CHEMICAL NEWS, vol. xlv., p. 304, I have examined at Messrs. Townson and Mercer's a specimen of his wash-bottle, of which I previously knew nothing. I find that it is very similar to mine; but inasmuch as the valve in mine is worked by the thumb, thus leaving the first finger free to move the jet in any required direction, I think it is rather more convenient than Mr. Foye's, in which the valve is worked by the first finger. My wash-bottle can be obtained from Messrs. Becker, 34, Maiden Lane, Covent Garden.—I am, &c.,

A. E. JOHNSON, Assoc. R. Coll. Sci. I.
St. George's Hospital, Dec. 29, 1881.

STRAW DYEING.

To the Editor of the Chemical News.

SIR,—I have experimented on straw very considerably, but I find that it has very little affinity for indigo and aniline-blue, although methyl-violet has a strong affinity. I have used most of the mordants, but still indigo extract does not seem to dye only a green, and then more dye is required than would make the dyeing with indigo remunerative. Could you suggest any method or do you know of any book that treats on straw dyeing. Beautiful colours are obtainable on straw, but the dyers (there are only two) keep it a secret.—I am, &c.,

Geo. Fyson.

GLYCERIN.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlv., p. 316, glycerin is mentioned as an agent for the preservation of meat, &c. If worthy of your notice, I can say that some forty years back, the late R. Warrington, of Apothecaries' Hall, and myself, made experiments upon the subject, and he proposed patenting the process. I do not know or remember that he went so far.

I note your remark as to the present rising in prices of glycerin.

I also call to mind a lecturer at the Society of Arts, some twenty years since, said glycerin would shortly become part of the food for fattening pigs.—I am, &c.,

J. B. ANDERSON.

Soap Works, Southwark, Jan. 2, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Journal für Praktische Chemie.
Nos. 6 and 7, 1881.

Communications from the Chemico-Agricultural Laboratory of the University of Königsberg.—H. Ritthausen.—These consist of memoirs on the albumenous bodies of the hazel nut, walnut, candle nut, and of radish seed, and on the distribution of myronic acid in the seeds of *Brassica napus* and *rapa*.

Komenic Acid.—Dr. T. Reibstein.—The author has studied komenic ethyl-ether, acetyl-komenic ethyl-ether

the action of nitric and nitrous acid upon komenic acid; nitro-komenic ethyl-ether with its salts, amido-komenic acid, komenamide and its salts, komenaminic acid, and its ether; the action of ammonia upon bromo-komenic acid; oxykomenic acid and its ethyl-ether, the salts of oxykomenic acid, oxykomenaminic acid, and the action of hydriodic acid upon komenic acid.

Methods and Researches of Physical Chemistry.—Otto Pettersen.—This chapter contains a thermic and volumetric investigation of formic and acetic hydrates. The author concludes that their volumes in the state of vapour are of equal magnitude at the same temperature and pressure. On solidification they evolve the same quantity of heat. On solidification they undergo a relatively equal contraction. Their expansion when heated is proportional, at least near the melting-point.

Certain New Brain Constituents.—Eugen Parcus.—The author finds that cerebrine cannot be deprived of nitrogen by repeated crystallisation from alcohol. It possesses properties very distinct from those of Müller's cerebrine. The body formerly known as cerebrine is a mixture of three closely related, indifferent, nitrogenous bodies, cerebrine, homo-cerebrine, and encephaline.

Anthology of Modern Chemical Utterances.—H. Kolbe.—Able but severe criticisms.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome viii., No. 94.

This issue contains no chemical matter.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 7, 1881.

Certain Telephonic Experiments.—A. Treve.—This paper consists almost entirely of illustrations.

The Pantelephone.—H. Valette.—This paper cannot be intelligibly reproduced without the accompanying illustrations.

No. 9, 1881.

Electric Currents produced by Atmospheric Electricity and Telluric Currents.—J. Landerer.—An account of the author's experiments made at Tortosa in 1878, and already noticed.

M. Gaiffe's Sulphate of Copper Battery.—This is an improvement on the Daniell element and is intended to put a stop to the reaction of the zinc on the sulphate of copper when the circuit is open. The apparatus consists of a glass cell, at the upper part of which is the zinc, constructed as in a Callaud element. The central vessel has a porous upper portion fixed upon a non-porous lower portion, which may consist of an ordinary drinking-glass. The copper cylinder placed in the central cell has a prolongation which is bent down so as to reach down to the bottom of the outer cell, where it terminates in a ring. This element is charged by means of a concentrated solution of zinc sulphate or magnesium sulphate, whilst some crystals of copper sulphate are placed in the bottom of the central cell. On dissolving, the copper sulphate first saturates the liquid in the non-porous part of the central cell, and when the copper solution reaches above the top of the non-porous part it traverses the porous cell, and falls, in virtue of its superior density, to the bottom of the outer cell, beyond the reach of the zinc. This passage of the copper sulphate is effected slowly, and the circuit may be left open for weeks without any deposit of copper being perceived on the zinc. When the circuit is closed this element first reduces the sulphate of copper which has fallen to the bottom of the outer cell, the liquid in which soon resumes its original purity, and the action then continues as in an ordinary Daniell element.

Researches in Electricity.—Captain Trève.—Not susceptible of useful abridgment,

The Electric Motor of M. Marcel Deprez.—This paper requires the accompanying illustration.

No. 11, 1881.

Note on Viscose.—E. Maumené.—With reference to a paper read by M. Béchamp at a recent meeting of the Academy of Sciences, the author points out that as far back as 1874 he gave the name viscose to the fatty matter of wines and gave a process for its isolation.

The Present Chemical Doctrines.—M. Gerber.—A continuation of a survey of modern chemical theories.

Column Lightning.—H. Menin.—An account of an electric storm where ordinary lightning fell from an upper stratum of clouds to a lower, whilst between the latter and the earth there appeared cylinders of a reddish violet light formed of two truncated cones united by their narrower extremity, apparently 200 metres in height by about 4 or 5 in diameter. Several of them were in sight at once, and the duration of each was from four to seven seconds.

Electric Machines.—H. Valette.—An illustrated paper.

No. 12, 1881.

Action of Cold on the Voltaic Arc.—Dr. Tommasi.—This paper has been abstracted from the *Comptes Rendus*.

The Electrolysis of Water (Continued from No. 10).—Dr. Tommasi.—The author maintains that he has, prior to M. Berthelot, announced that water may be decomposed by a single thermo-chemical element, contrary to theory, if the positive electrode is formed of a substance which, under the influence of the current, may seize hold of the oxygen of the water.

No. 13, 1881.

Waste Liquor from Distillers as a Manure.—MM Gaillet and Huet.—The liquor is mixed first with ferric chloride and then with milk of lime. The ferric chloride carries down with it almost all the organic matter, leaving an effluent clear, colourless, harmless, and imputrescible. [It is singular to find the treatment of organic liquids with any cheap metallic salt, followed, if needful, by lime-water, put forward as a new invention!—Ed. C.N.]

MISCELLANEOUS.

A Caution.—Analytical chemists are cautioned against a man, age 40, height 5 feet 9 inches, reddish whiskers and moustache, and florid complexion, who falsely represents himself as the brother of Dr. Cameron, of Dublin, and endeavours to obtain money under the plea that he is destitute. He is an impostor, and on making such false pretence should be given into custody.—METROPOLITAN POLICE OFFICE, January 3, 1882.

MEETINGS FOR THE WEEK.

- MONDAY, 9th.—London Institution, 5.
Medical, 8.30.
Society of Chemical Industry, 7.30. "On Some Recent Improvements in Industrial Chemical Processes," by W. Weldon.
TUESDAY, 10th.—Institute of Civil Engineers, 8.
Royal Medical and Chirurgical, 8.30.
Photographic, 8.
WEDNESDAY, 11th.—Society of Arts, 8. "The Industrial Resources of Ireland," by G. Phillips Bevan, F.G.S.
Obstetrical, 8.
Geological, 8.
Microscopical, 8.
THURSDAY, 12th.—Royal, 4.30.
London Institution, 7.
FRIDAY, 13th.—Quekett Microscopical Club, 8.
Astronomical, 8.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1154 JAN 82

ON CERTAIN INDIGENOUS DRUGS OF INDIA.

By Surgeon C. J. H. WARDEN,
Chemical Examiner to Government, and Professor of Chemistry,
Calcutta Medical College.

Gloriosa superba.—The isolation of *Superbina*, the active principle of *Gloriosa superba*, was recorded in the last report. When purified it is a yellow non-crystalline neutral principle, to which the formula $C_{52}H_{60}N_2O_{17}$ has been assigned. It is readily soluble in water, alcohol, chloroform, and dilute acids: with tannic acid it gives a white precipitate, but is unaffected by other reagents. It is extremely poisonous, 0.0107 of a grm. being a fatal dose for a large cat. The following is a list of the chief substances which are found associated with *Superbina* :—

Alpha-resin	$C_{30}H_{59}NO_{14}$
Beta-resin	$C_{17}H_{30}O_2$
Gamma-resin	
Fluorescent principle ..	
Salicylic acid	
Methyl salicylate	

Alpha and gamma are acid resins; beta-resin is neutral; all are physiologically inert. A detailed account of the research has been published in the *Indian Medical Gazette*.

Thevetia Neriifolia.—No reference to the fact of a poisonous principle having been isolated from the seeds of *Thevetia neriifolia*, the exsile or yellow oliander, is made by any of the recent authorities on Indian indigenous drugs. In the Indian Pharmacopœia it is stated that a tincture made from the bark in small doses proved highly satisfactory in the treatment of intermittent fever, but that in larger doses it acts as an acrid purgative and emetic, and carried to a greater extent is evidently powerfully poisonous. The kernels are described as extremely bitter, and when chewed produce a slight feeling of numbness and heat in the tongue: by expression a pale amber-coloured, slightly viscid, acrid oil is procurable, sometimes used as a cathartic by natives, but producing violent vomiting and hypercatharsis. Reference is made to a non-fatal case of poisoning by one of the kernels, and, from the symptoms detailed, the poisonous principle is classed with acro-narcotic poisons. In addition to the above information, Dr. Norman Chevers, in his "Manual of Medical Jurisprudence for India," mentions a case communicated by Baboo Kanny Lal Dey, in which a child playing under a *Thevetia neriifolia* tree picked up and ate one of the seeds, which much resembles the almond. In a short time vomiting commenced, but there was no purging. Within half an hour the child was insensible; the body covered with cold clammy sweat; the countenance pale, and the eyes deeply sunken; and within two hours the patient died convulsed.

A chemical examination of the seeds was therefore undertaken, and resulted in the isolation of a white crystalline glucoside, slightly bitter, with a faint metallic taste, rapidly followed by a pricking and numbing effect on the tongue. A centigram. injected into the stomach of a cat produced no apparent effects: a decigram. dose, however, was fatal in twenty-five minutes, death being preceded by most violent convulsions. The oil obtained by acting as the kernels with benzene produced no effect on a cat in a drachm dose.

This research has, however, been very disappointing,

because I have recently ascertained that a glucoside was isolated in 1868 by Cl. Blas from the kernels of *Thevetia neriifolia*, and called thevetin, and the formula $C_{108}H_{84}O_{48}$ assigned to it. The results of the investigation were published in the *Bull. de l'Académie Royale de Médecine de Belgique* (Gmelin's "Handbook," vol. xii.). Thevetin dried over sulphuric acid is stated to contain six atoms of water, two of which are lost at 110° C. The percentage composition, calculated from the formula $C_{108}H_{84}O_{48}$, requires, carbon 60.3351, hydrogen 3.9106, and oxygen 35.7543 per cent, and with six and four molecules of water respectively—

	6H ₂ O.	4H ₂ O.
Carbon	57.4468	58.3783
Hydrogen	4.2553	4.1441
Oxygen	38.2979	37.4776
	100.0000	100.0000

The percentage composition obtained by me appears to differ somewhat from the above figures. The mean of eight ultimate analyses of thevetin dried at 145° C. gave the following results :—

Carbon	57.4083
Hydrogen	7.4775
Oxygen	35.1142
	100.0000

By acting on thevetin with dilute sulphuric acid, Blas obtained thevesin, $C_{96}H_{70}O_{34}$, and glucose. I have repeated this experiment, but at present have not made any combustions of thevesin. I am also engaged in examining the leaves and bark of *Thevetia neriifolia*, which apparently have not hitherto been analysed. I would remark that in the abstract given by Gmelin of Blas's article no mention is made of thevetin possessing poisonous properties.

Abrus precatorius.—The examination of ruttee seeds, which, when made into needles, are used for cattle poisoning, has occupied considerable attention, but I regret that the active principle has not yet been isolated. The chemical examination of the seeds has resulted in the separation of a crystalline acid and oil and certain extractives. By acting on the seeds with boiling alcohol, a white crystalline acid is obtained, to which the name *abric acid* has been given, and the formula $C_{24}H_{24}N_3O_4$ assigned. This acid is slightly soluble in cold, but dissolves in boiling water, and crystallises out in delicate white microscopic needles. With alkaline bases it forms well-defined crystalline salts. The following is a brief resumé of the physiological experiments which have been performed :—

- Half a seed rubbed down with cold water, and the mixture hypodermically injected into a cat's thigh, produces fatal effects in from eighteen to thirty hours. The seeds weigh on an average two and three-sixteenths of a grain. For the first eight or ten hours after the injection no symptoms are apparently produced; a gradual disinclination for exertion then supervenes, which slowly increases until the animal is unable to move. The respiration becomes shallower and shallower; the animal lies on its side and slowly dies. No convulsive movements or twitchings of the muscles have been observed, and there is neither diarrhoea nor vomiting.
- An alcoholic extract prepared with boiling alcohol is inert.
- The residue left after the action of boiling alcohol on the seeds is also without effect.
- Abric acid and abrate of ammonia are inert.
- Some of the powdered seeds were distilled with water at a temperature of 100° C. Neither the distillate nor the residue left in the retort produced any symptoms.

* From the Annual Report on the Chemical Examiner's Department for the financial year ending 31st March, 1882.

- (f) An extract prepared by spontaneous evaporation with cold alcohol produced no effects.
- (g) An extract similarly prepared with ether produced fatal effects with the usual symptoms. In a second experiment, conducted apparently under similar circumstances, no effects were produced.

It would appear that a temperature of 100° C. destroys the activity of the poison.

Wrightea antidysenterica.—In my last report I stated that Baboo Ram Chandra Dutta, Second Assistant in the Laboratory, had re-discovered the active principles of kurchi bark. The bark of *Holanhena antidysenterica* was formerly imported into Europe under the names of "Cenessi bark," "Codaga pala," "Corta de palla," and Tellicherry bark. In 1858 an alkaloid was separated from it by Haines, and seven years after the late Dr. Stenhouse again described the alkaloid under the name of Cenessine.

It is a curious fact that this alkaloid appears to have been thus twice re-discovered.

The purification of kurchicene being somewhat difficult, it occurred to Baboo Ram Chandra Dutta that an acetic solution of the crude alkaloid might be as efficacious as pure kurchicene. A solution was therefore prepared, containing three grains of kurchicene in each fluid drachm of the solution.

Dr. J. M. Coates, Principal of the Medical College, tried the effects of the extract of kurchi on some patients in the Medical College Hospital, and has kindly furnished me with the following note:—

"We have used kurchicene to a limited extent in this hospital, both in fevers and in dysenteries, though in very few of the latter. So far as we have gone, we have found that it has decided antipyretic effects in fevers.

"It is most effectual in those which have chylipoietic congestions. In these the tongue cleaned, the bile appeared in the stools, digestion improved, and the fever ceased, under drachm doses of the liquor, one to three times a day.

"It is less effectual where the spleen is enlarged and blood anæmic, though in one case it distinctly modified the temperature where quinine, even in large doses, had failed.

"In dysenteries, in half to one drachm doses, it was also beneficial.

"In the three acute cases the fever abated and the stools became fewer in number, more consistent in quality, and more bilious in character, but the blood and mucous were little affected. They abated for a time, but reappeared, again and again, in spite of the kurchicene.

"In the two chronic cases we had nearly the same result, though the benefit was less marked in these than in the acute.

"In dysenteries I hold it to be an excellent adjunct to our ordinary treatment of this disease, but it is not an entire substitute for these."

ON THE
ACTION OF WATER UPON LEAD PIPES,
BEING A

TRANSLATION FROM THE FRENCH OF M. BELGRAND.

By W. SEDGWICK SAUNDERS, M.D., F.S.A.,
Medical Officer of Health and Public Analyst for the City of London,
Late President of the Hunterian Society, &c.

(Concluded from p. 9.)

Action of Chemically Pure Lead on Different Waters.

The lead is immersed in water, and the liquid exposed to the air. About 25 grms.* of pure lead, and 250 cubic centimetres† of water are used. (See Table next page.)

* A gramme is equal to 15.438 grains troy.

† A cubic centimetre is equal to 0.99872, or nearly two-fifths of an English inch.—W.S.S.

Which salts are the most efficacious, when present in minute quantities, in preventing oxidation of lead in contact with water? Salts of lime alone are unquestionably so, even in the smallest proportions; in the absence of lime other salts are capable of protecting lead, in quantities of 0.1 grm. per litre. Nevertheless after from 24 to 30 hours the water becomes faintly coloured by sulphuretted hydrogen; but this oxidation soon ceases. The following experiments were made to ascertain the particular influence of different salts.

Solutions were made with sulphate of soda, chloride of sodium, chloride of potassium, sulphate of magnesia, the strength of each solution being 0.1 grm. per litre. The lead was immersed in these for 24 hours, when the water became coloured by sulphuretted hydrogen, but the solvent action did not continue, and it may be said that the solutions in question are without notable action upon lead, for, at the end of 10 days, the reagent did not produce any real precipitate. These experiments will be continued by varying the proportions.

We have, with M. Le Blanc, undertaken another series of experiments by operating upon water under the most favourable conditions for its contamination, and have obtained some traces of lead in the residue left by evaporation. As soon as this further inquiry is terminated I will forward the results to the Academy.

Upon the whole there is absolutely no danger of poisoning from the use of water flowing through leaden pipes.

It would doubtless be very difficult to compel, as has been suggested, the Parisian houseowners to replace the 1500 kilometres of lead branches at present existing in their property, since it is found that the interior of these pipes are perfectly smooth, without a trace of injury, and coated with a thin crust of adherent deposit, which prevents the contact of the lead with the water.

I do not think that any other mode of distributing water can be recommended, even to nervous people; the iron pipes so much used in London on account of their low price, are less suitable for Paris, first because the necessary joints and connecting pieces are not to be found in commerce, but especially as accidents from frost, more to be feared in Paris than in London, are more formidable with iron pipes than with lead.

Leaden pipes lined with tin have been lately recommended. These are very expensive, and possess the grave objection that in soldering the joints the inner tin casing (or lining) is melted, and creates obstructions in the pipe.

I have obviated this difficulty by causing the tin to be melted beforehand off those ends of the pipes intended to be soldered, for a length of 8 to 10 centimetres (three to four inches), in a sand bath heated to more than 227° C.,* the melting-point of tin, and less than 330° C.,† the point at which lead fuses. It is true that a small surface of lead is left unprotected by this device, but, in my opinion, for so short a length as to be practically unimportant. One cannot, however, advise the employment of these, since they are too novel for us yet to know all the disadvantages which they may possess. In reality none of these pipes can have any effect whatever on the health of the public. The administration has therefore adopted the only sensible course in authorising subscribers to use, at their own pleasure, and on their own responsibility, either the leaden pipes, or those of iron, cast or otherwise, or those in lead lined with tin; on the sole condition of giving to all pipes laid under the public roadway the thickness necessary to resist the pressure of the water.

At the same sitting of the Academy M. Dumas made the following communication:—

"M. Fordos has requested me to present to the Academy the paper that will be read later.‡ In complying with the desire of that learned chemist, and quite

* 227 degrees Centigrade, equal 440.6 degrees Fahrenheit.

† 330 degrees Centigrade, equal 626 degrees Fahrenheit. W.S.S.

‡ See the Transactions of the Academy of Sciences of Nov. 10, 1873

Nature of the Waters.	Date of Immersion.	Observed Result.
Distilled Water	September 27.	Considerable action, White Crystals of Hydrated Oxide of Lead formed.
Water from the Seine (1)	do.	No effect produced.
Water from the Dhuis (2)	do.	do.
Water from Grenelle Well (3)	do.	do.
Water from Ourcq (4)	do.	do.
Water from Arcueil (5)	do.	do.
Water from Belleville Well (6)	do.	do.
Northern Spring, Près St. Gervais (7)	do.	do.
Water from Well at Passy	do.	do.
Water from the Reservoir of Gulf d'Enfer à Saint-Etienne (granite formation). Hardness 1.44° (8)	October 8.	do.
Water from the Reservoir of Settens (Morvan) River of Cure. Hardness 0.96 (9)	do.	do.
Water of the Ourthe (Belgium) Devonian formation. Hardness 0.96	October 15.	do.
Rain Water collected in Quay at Be-thune.	October 8.	{ No visible effect. Traces of Sulphate and of Lime.
Rain Water collected on the Reservoirs of Mésilmontant	October 28.	{ The corrosion of the Lead was evident at the end of 24 hours, and went on increasing. Deposit very abundant on November 5.

- (1.) At the mouth of the Aqueduct of Mésilmontant.
(2.) In the middle of the stream, near the supply for the Orleans Railway.
(3.) At the top of the well.
(4.) In the middle of the Inner Circle Station.
(5.) From the Aqueduct.
(6.) House, 19, Rue Fessart.
(7.) From near Mossins, behind Bastion 20.

- (8.) This reservoir generally contains 1,600,000 cubic metres of water.
(9.) This reservoir has a capacity of from 19 to 20 millions of cubic metres.

NOTE.—The pipes encased in tin were not more attacked than the leaden town pipes. The well water of Grenelle was employed for comparative experiments.

accepting the results which he announces as to the effects of prolonged shaking of grains of lead* in contact with air and water, and also the inferences which he draws with regard to rinsing bottles, the Academy will allow me to make some remarks upon the contact of potable water with vessels or pipes of lead. I made long ago in my public lectures the following experiments. Five flasks being filled with grains of lead, I poured some water into each.

1. Distilled water.
2. Rain water.
3. Water from the Seine.
4. Water from the Ourcq.
5. Well water.

"I showed by the action of sulphuretted hydrogen (H_2S) that the water of the first flask gave evidence almost immediately of a trace of oxide of lead dissolved in it, while the flasks which contained water more or less charged with lime salts did not contain any."†

"The rapidity with which distilled water takes up lead is surprising; the effect produced by even traces of lime salts in preventing this contamination is not less so. One cannot forbear comparing these facts with those which M. Schloessing has observed with reference to the white clay which will remain indefinitely suspended in pure water, but which the very faintest trace of lime salts will precipitate."

"The properties of absolutely pure water are hardly yet known, and they differ, I dare say more than is supposed, from those of ordinary water."

The following note of M. Chevreul has been published in the *Comptes Rendus* of the meeting of November 17th, 1873.

"Want of time having prevented me from inserting in the Minutes of the meeting of November 3rd some observations in relation to the action of pure water on many

metals, which were suggested to me by the communication of M. Fordos and of M. Belgrand, I must ask the Academy kindly to allow the following observations to be inserted in to-day's Minutes."

1. Observations in Relation to Hygiene.

"In the *Bulletin des Séances de la Société Centrale d'Agriculture de France* (July 9th, 1873), in reference to a petition from M. de Laval to the Corporation of Paris, to do away with leaden pipes, I made the following remarks:—

"Our Vice-President, M. Chevreul, will recollect the remarks which he made at the Gobelins, upon the action of distilled water on lead and zinc, an action which is not exerted by hard waters which contain certain salts in solution."

"He also will remember having told the Society that similar observations were made long before his own by M. Guyton de Morveau, who had noticed that pure waters acted not only upon lead but also upon zinc. It is to M. Guyton, added M. Chevreul, that the merit of the observation in question is due."

Furthermore, in the *Journal des Savants* (October, 1871, p. 488), one reads:—

"It may not be inopportune to draw attention to a fact not sufficiently known to the public, namely, that rain waters alter leaden and zinc vessels more than waters containing salts in solution, well waters for example. The result of this is that these latter waters may remain in a leaden vessel without attacking it, and without becoming poisonous, while rain waters, free from saline matters, dissolve oxide of lead and thus become poisonous. This observation quoted from Guyton de Morveau is perfectly true. I have verified it at the time of my investigation on the waters of the Bièvre."

"If particular circumstances had not prevented me from going to the Gobelins to-day to seek the results of experiments dating back to 1836, and which I will lay before the Academy in due course, you could have seen the effect of distilled water, as compared with that of well water, upon a sheet of lead, and also a similar difference

* Probably leaden shot.

† If one takes some water from the first rain which falls after a dry period, it is found charged with lime particles which the later rains, having traversed pure air, do not contain; according to the rain-water chosen then, the effects may differ, still, as a whole, the rain-water of Paris is almost identical with the water of the Seine.

between iron and steel in distilled water, and the iron and steel in an alkaline liquid.

"I had occasion in 1844 to notice a fact relating to hygiene and to ordinary economy, which was, that in a great industrial establishment, the name of which it is unnecessary to give, they had invented a method of preparing calico with the sulphate of lead obtained in the preparation of the cotton weavers' dye, by the reaction of acetate of lead and alum. It happened that a Stèvres washer-woman, whose customers belonged especially to that part of Paris where the warehouses of dyed linen goods are situated, was greatly astonished to see the linen which she had washed come out black and discoloured from her wash-tub. The explanation was that she used soap lees prepared with a mixture of soda, of potash, and of sulphide of lime, and that this at once caused the formation of black sulphide of lead with the sulphate of lead in the clothes. I have narrated this fact in the *Comptes Rendus* of the meeting of September 16th, 1844.

"In 1841 I was directed by the Minister of Marine to examine, conjointly with M. Lebas, whose name is so closely associated with that of the Luxor obelisk in the Place de la Concorde, several methods of purifying the water for use in the navy. Among these methods was included that of distilling sea water by means of the apparatus of a Nantes operative. We discovered the presence of copper, derived from the metal of the condenser, in the water thus distilled; and after having ascertained that a drinkable water could be obtained from a sample giving a reaction with sulphuretted hydrogen by passing the water through a carbon filter, which, by capillary attraction, would take up the copper, we advised the authorities to instruct the doctor on board to have some stoppered flasks of one decilitre in capacity, containing solution of a sulphate and oak shavings, so as to obtain a reagent capable of showing not only the presence of copper, but also that of lead; because the soluble sulphate in the water is transformed, after a few days, into sulphide by the soluble oxidisable matter of the oak wood."

II. Observations in Relation to the Arts.

"I remind you that the presence of a copper salt in the tissues of wool, which is intended, for example, to be subjected to the action of steam after being printed, causes it to assume an orange colour, because the sulphur of the wool produces a coloured sulphide, under the influence of heat and moisture." A brown or black sulphide will be produced if the tissue contain some salt of lead, as happened in 1844, when in the manufacture of some woollen tissues in Picardy, a weaver had used a gelatine which the maker had whitened with acetate of lead; and thus the impregnation of the warp with this gelatine caused the tissues, after being printed and passed through steam, to become stained."†

III. Observations in Relation to Chemistry.

"In 1837‡ I called the attention of chemists to a fact to which I attach great importance; it concerns the use of reagents in chemistry.

"I recognised that all alkaline reagents which were kept in flasks of white glass, in the manufacture of which, in order to give greater whiteness, fragments of leaden glass are largely used, contain from that source oxide of lead in solution. I thought it right, therefore, in the interests of science, to show the necessity of keeping the reagents of which I speak in future always in vessels of green glass. It is here not only a question solely of pure science, but also of toxicological analysis, and nobody will blame me for recommending an examination of the reagents used, knowing that the experts chosen to perform such analysis always make what are called blank experiments in order to avoid all errors, and especially those which might be due to the reagents employed.

"Since it is a scientific question, an important communication made at the last meeting on the influence of salts in causing the precipitation of white clay in suspension in water, encourages me to make the two following remarks:—

"The first is, that this communication proves the proposition that I have several times enunciated, and that quite recently, on the solvents. In fact, I have remarked that the moment a solvent takes up any substance in solution it becomes a different solvent from the original one; in other words, it can now dissolve bodies which it could not dissolve when in a state of purity, and this is the cause of one of the greatest difficulties of proximate organic analysis."

"The second is, that in the article, *Gold*, written for the *Dictionnaire des Sciences naturelles*, an article which appeared in 1825, in volume 36, I said, after speaking of a method of preparing the Purple of Cassius by the nitrate of proto-oxide of tin: 'I have several times noticed that the addition of a few drops of a solution of a neutral salt, such as sulphate of potash, at once brings about a deposit in a liquid which would have otherwise been several days without giving a precipitate.'"

Conclusion.

"After having heard the advice given by M. Belgrand in reference to the conveyance of spring waters through leaden pipes,* I share his opinion as to the usefulness of leaden pipes on condition that a test is made in every case where it may be suspected that the water has remained too long in contact with the metal."

I have received the following supplementary information on the distribution of water in different towns:—

Glasgow.—Enormous supply of water from Loch Katrine. Hardness from 3 to 5 degrees. In consequence of the purity of this water, contamination with lead was much apprehended; however, the house pipes were made of this metal, as in Paris, and experience has shown that no inconvenience has resulted.—(Information given by M. Mille, Inspector-General of Roads and Bridges.)

Brussels.—Water derived from chalky sources, like the water of the Vanne. The hardness probably varies from 18 to 20 degrees. According to M. Mauss, Inspector-General of Belgian Roads and Bridges, the public conduits are of cast-iron, the house pipes of lead. The harmlessness of the system is established, and yet a journal, published in Brussels, made a furious onslaught on the leaden pipes of Paris, forgetting those of its own town.

Lisbon.—Water of variable quality, in part very pure, showing only two or three degrees of hardness. The main services of cast-iron, house pipes of lead; the system was answering very well, till the "war against lead" broke out and disturbed the public mind.—(Information given by M. Larcher, Engineer and Peer of Portugal.)

Avallon.—Water from granite formation. Standard of hardness from one to two degrees. Public conduits of cast-iron, house pipes of lead. This method of distribution in use since 1847, and despite of the purity of the water, without any ill result. So-called centenarians are not rare in this pretty little town.

Decomposition of Water by the Electric Effluve in Presence of Nitrogen.—MM. Dehérain and Maquenne. —The apparatus in which electric exchanges take place through one or two isolating envelopes may produce not merely the effluve, the phosphorescent light, and the rain of fire, according to the tension and the nature of the gas introduced into the apparatus, but even, if the isolating sides are moist, an electric manifestation closely resembling the spark. It is capable of combining nitrogen either with oxygen or with carbon.—*Comptes Rendus*.

* *Comptes Rendus*, December 26, 1837.

† *Ibid.*, September 16, 1844.

‡ *Ibid.*, December 26, 1837.

* The part of my paper to which M. Chevreul alludes has from lack of space not been printed in the *Comptes Rendus* of November 10, 1873. It will appear in the next communication.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, December 13, 1881.

J. P. JOULE, D.C.L., LL.D., F.R.S., &c., in the Chair.

"Remarks on the Terms used to denote Colour, and on the Colours of Faded Leaves," by EDWARD SCHUNCK, Ph.D., F.R.S.

At the recent meeting of the British Association held at York, a paper was read by Dr. Montagu Lubbock before the section for anatomy and physiology on "The Development of the Colour Sense," which I had the pleasure to hear. The purpose of the author was to controvert the opinion of those who hold that the colour sense in man was not always what it is now, but that it has gradually been developed, the last stages of this development having taken place within historical times. It is supposed that the human eye was originally only capable of distinguishing black and white, and that the capacity of seeing the various colours of the spectrum arose by degrees, red being the first, and blue the last colour to be discriminated. Mr. Gladstone, in a paper published not long ago, goes so far as to say that the ancient Greeks, having no word for blue, were blind to that colour, and that it is only since their day that human vision has been so far developed as to perceive the more refrangible end of the spectrum. The author of the paper referred to arrived at the conclusion that there is no sufficient evidence to show that the faculty of perceiving colour has been acquired by man within historical times, a conclusion in which Sir John Lubbock, who took part in the discussion on the paper, entirely concurred. Whatever may have taken place in pre-historic times, there can be little doubt, I imagine, looking at the remains adorned with various colours in Egypt and elsewhere, that the more civilised nations of antiquity, though they had fewer pigments at their disposal than we have, were quite as capable of distinguishing colours as we are. It may indeed be asserted that so far as appropriate arrangement of tints in dress and other articles of daily use is concerned, no advance has been made since the time of the ancients, but rather that we have in this respect retrograded. Evolutionists tell us that we may obtain a good idea of what our pre-historic ancestors were, by observing the present state of savage and uncivilised races, a state from which we have in the course of ages emerged. So far, however, as the appreciation of colour is concerned no superiority on our part can be discovered, for whoever will, with an unprejudiced eye, compare the harmonious combinations seen in the articles produced by the less civilised nations of India and China, or by the natives of America and Polynesia, with the hideous contrasts and tasteless arrangements so often displayed in our articles of dress and furniture, will probably incline to the opinion that in this respect we may rather be called savages, and that the incapacity for appreciating colour harmony inherent in the Teutonic branch of the Aryan race has not been removed, but rather intensified by civilisation. Much has, indeed, been done of late to promote good taste in this as in other departments of art, though our progress has probably been retarded by the introduction of various artificial colouring-matters, the extreme brilliancy of which acts as a lure to the uncultivated eye.

Though much of the uncertainty which exists as to the precise meaning of the words used by the ancients to denote colour is of a philological kind, part of it is due, I think, to causes which are still in operation.

1. The ancients, having no fixed scale of colour to refer to, such as we possess in the spectrum, were unable to compare any given tint with that which it exhibits in its highest state of purity, whilst we, by means of the fixed

standard at our command, and with the assistance of the so-called chromatic circles and other appliances, can determine not only the exact position and shade of any given colour, but also the extent to which it is degraded or rendered impure, and though the general public very slowly adopts scientific terms and methods, still on the whole the tendency in our days is towards exactitude, and vague terms for objects and sensations are more and more falling into disuse.

2. In one respect the ancients must have laboured under the same disadvantage in determining the value of colour as we moderns do. We very seldom see one colour alone, but generally two or more in juxtaposition, and contrasted, and by contrast the effect of each colour on the human eye is considerably modified. Complementary colours, when seen in close proximity, heighten one another. Green next to red will appear much brighter than when placed close to blue. A colour of average purity will appear dull when compared with a brighter colour of the same hue, while it will seem bright when seen alongside a more dingy shade, and so on. Unless great care be taken, therefore, we are liable to become inaccurate when describing a colour, though, on the other hand, it may be doubted whether, if the human eye were so constructed as to see only one of the colours of the spectrum, we should from the absence of contrast be able to appreciate that colour correctly.

To the fact that we almost always see colours in contrast must be ascribed the habit which men have of speaking of "beautiful colours." No one who has thought on the subject need be told that a simple sensation cannot be strictly speaking beautiful. It is only by combination, contrast, and harmony of sensations that we arrive at beauty. To talk of a beautiful sound, such as a single note of a musical instrument, would be absurd; it is only a combination of sounds that can be called beautiful. The terms "beautiful smell," "beautiful taste," would cause the most ignorant to smile, though it may be contended that a dish uniting various flavours, or a perfume composed of well-assorted scents might be called beautiful. We look at the spectrum thrown on a screen, and say it is beautiful, but it is the effect of the various colours seen in juxtaposition, and the exquisite shading and melting of one into the other that we admire. When we speak of the beautiful colours of sunset, we forget that a fine sunset is in fact a grand chromatic display. We see the fiery red of the fleecy clouds and the deep blue of the sky contrasted with the green of the foliage, and the brown of the tree stems, followed by a flood of yellow light on a cool grey ground in the heavens, while the gloom of night is settling over the earth beneath, and the eye is pleased and satisfied. Were we to see the sun like a ball of red-hot iron set through a coppery sky over a sea of blood washing a coast line of red rocks overgrown with red seaweed, it is certain we should not speak of the beautiful colours of sunset. Let any one, to test what I maintain, look at any colour, however brilliant and pure, through a tube blackened inside, and say whether it appears beautiful. It is the great activity of the eye, which during our waking hours is constantly roaming from object to object, seldom seeing the same thing nor the same colour for more than a few consecutive moments, that deceives us.

3. Much of the confusion as regards the names of colours arises, as it has doubtless at all times arisen, from the habit, difficult to explain, of using inexact designations, and even applying names to colours which we know to be incorrect. Poets, for instance, call gold red, though it is always yellow. We speak of white wines and red wines, though in reality, as we are well aware, they are yellow and purple, so that in a thousand years hence it may be possible for a literary man to say that we were colour-blind, our eyes having not yet acquired the capacity to see yellow and blue, yellow appearing to us colourless and purple red; and he may in support of this assertion quote the line of a distinguished poet now living who speaks of the "costly scarlet wine," a term which is still

more precise and emphatic than simple red. In the course of an investigation, undertaken a short time ago with another chemist, I found that my collaborateur and myself never exactly agreed as to the names to be given to the colours we saw. The series which he named blue, violet, purple, crimson, red, orange, I called violet, purple, crimson, red, orange, yellow, *i.e.*, what was to his eye blue was to mine violet; his violet was my purple, and so on. There was no reason to suppose that our perception of colour differed, the difference was in my opinion simply one of terms.

The writings of ancient authors abound with instances of the use of colour names which are seemingly incorrect. We find in "Horace" (Book IV., Ode 1) the lines:—

Tempestivus in domum
Paulli, *purpureis* ales oloribus
Comiss abere Maximi,
Si torrere jecur queris idoneum.

Another author says:—

Purpurea sub nive terra latet
Brachia purpurea candidiora nive.

We are told by scholars that in these cases *purpureus* means bright, shining, but it still remains to be explained why a word, which generally denotes a positive colour, whatever that colour may have been, comes in a few instances to be applied to white objects, such as swans and snow. Of course the definition of a word may be so extended as to include any number of widely different meanings, some of these meanings being perhaps due to its mistaken use by authors. It would probably not be difficult to find passages in modern authors in which the word blue sometimes means green, sometimes violet. I met with a case in point recently on reading again Goethe's delightful autobiography "Wahrheit und Dichtung." The author, when a young man, was skating on the river on a bitterly cold winter's day. "I had been on the ice," says he, "since early morning, and was therefore, when my mother later in the day drove up to admire the scene, being only lightly clad, almost frozen. She sat in her carriage wrapped in a red velvet fur mantle, which, held together in front with thick gold lace and tassels, looked magnificent. 'Give me, dear mother, your fur cloak,' said I, without much consideration, 'I am fearfully cold.' She, too, did not consider long, and the next moment I had put on the cloak, which, reaching nearly to my feet, being of a purple colour, trimmed with sable, and ornamented with gold, suited very well the brown fur cap which I wore." Here it is evident that Goethe calls the same object first red, then purple, and yet Goethe was not colour-blind; he wrote, as everyone knows, a work on the theory of colours.

4. Part of the vagueness and uncertainty attending the terminology of colour may be ascribed to a tendency we are all more or less liable to, that of describing colours in figurative and metaphorical terms. The habit, no doubt, arises from the pleasure we feel in comparing two objects, both of which are agreeable to the sense of sight. We speak of a girl having sky-blue eyes and cherry-red lips, whereas slate-coloured and brick-red would be more correct. How often we hear the expression, "he turned as white as a sheet," whereas the human skin is never under any circumstances, even after death, as white as a sheet. To say "he turned of a dirty yellowish white," would be nearer the truth, though the expression might be thought somewhat inelegant. Poets and others speak of golden hair and silvery locks, but human hair, though it may be bright, glistening, and so on, never reflects light in the manner peculiar to metals. Numerous examples of the same kind will occur to everyone. If, therefore, we meet in ancient authors with expressions relating to colour which seem exaggerated and out of place, we must make some allowance for the tendency shown by men at all times to compare one beautiful object with another beautiful object, or one terrific object with another terrific object, without regard to exact literal truth. Generally

speaking, I think we may safely say that no terms denoting colour, wherever met with, are to be considered strictly correct and appropriate unless they are referred to some fixed and known standard. The errors due to actual colour blindness need hardly, I think, be taken into consideration, since the hues which the colour blind are unable to distinguish lie so far apart as to make it difficult for anyone with normal eyes to conceive the possibility of so great a defect.

The brilliant tints exhibited by the decaying foliage of the trees in this neighbourhood in the course of the autumn, forming a chromatic display such as those living near manufacturing towns have few opportunities of witnessing, have led me to think a little on the cause of the formation of these colours and its possible connection with chlorophyll, on the chemistry of which I have lately been making some experiments.

The colour of the leaves of plants is a phenomenon which is probably never quite stationary at any period of their development. When lying rolled up in the leaf bud they are like underground shoots and other parts of plants that have not been exposed to light, almost white; nevertheless they already contain a colouring-matter called *etiolin*, the alcoholic solution of which is yellow and shows absorption-bands similar to those of chlorophyll. Whether this *etiolin* on the leaf unfolding passes over into chlorophyll and whether it continues to be formed during the further stages of development is not known. All we know is that when the leaf expands it immediately becomes green from the formation of chlorophyll. It is, however, evident that more than one colouring-matter is formed after exposure of the leaves of plants to light. The colour due to chlorophyll alone is probably seen in its purest state in the tender exquisite green of the young beech leaf or blade of corn. Other leaves, such as those of the oak, before attaining maturity have a decidedly yellow tinge, due it is supposed to the presence of an unusual proportion of phylloxanthin, the yellow colouring-matter always accompanying chlorophyll. Indeed, the lively contrast of tints seen in the foliage of the woods in early spring, the yellowish hue of the oak, and the pure green of the beech and larch relieving the sombre colour of the fir tree and the yew, affords one of the most pleasing sights of that delightful season. In early summer the young shoots of some trees, such as the oak, the sycamore, and the thorn, as well as the young leaves near the summit of each shoot, are tinged of a lively red, passing by degrees into the green of the mature leaves. The fruit wings of the sycamore are for many weeks in the summer similarly tinted, and the effect of the pink blush gradually shading off into the pale green of the wing tips is one that painters might introduce with advantage into their pictures of still life. This red colour is said to be due to erythrophyll, the colouring-matter formed in some leaves in the autumn, but whether the substance is in both cases really the same may be doubted. At the height of summer the foliage of trees displays a uniform green tint of varying depth, but it is probable that at this season the chlorophyll has already undergone a change, and I suspect that the sombre green of some leaves, such as those of the elm, in summer, is partly due to a product of decomposition called "modified chlorophyll," which yields solutions of a much less lively colour than the chlorophyll from which it is formed.

The summer stage is succeeded by that of the autumnal fading of foliage, a change so often observed that it needs no description. With the exaggeration so often employed when coloured objects are referred to, people frequently speak of the multitudinous tints of autumn. In reality, however, these colours, not counting the original green, are only four in number, *viz.*, yellow, brown, red, and purple, and of these the last is a dull inconspicuous colour, while the red occurs so seldom in our native trees as to add but little to the total effect when our woods and plantations appear in their autumnal clothing. It is to the

Passing of the original green into yellow, and from yellow into brown, and the various shades and tints so produced that the effect is in the main due. The yellow colouration is most distinctly seen in the chestnut and the elm. In the latter the gradual tinging of the deep green with yellow produces a peculiarly beautiful effect, and when the change is complete, and the whole tree (to use one of those figurative expressions to which one is so prone) is arrayed in a garb of gold, the appearance when first seen is almost startling. Arrived at this stage the leaves mostly fall, but retain their yellow hue for a short time only, the colour under the influence of air and moisture rapidly becoming brown, though they remain yellow if quickly dried. The oak and the beech keep their leaves after the yellow stage is passed, and the rich reddish brown they then exhibit forms a distinct feature in the autumnal landscape. Young beech trees, as everyone knows, remain clothed with brown leaves during the winter, and only lose them on the unfolding of the fresh leaves in spring.

The leaves of some of our native plants, such as the wild cherry, the currant, the bramble, and various species of sorrel, turn of a lively red in the autumn, but this colouration intensified to a positive scarlet is more distinctly seen in some of the exotics which have been introduced into our gardens, such as the Virginia creeper and the Azalea. A mixture of red and yellow is rarely observed on the same leaf. It is a singular circumstance that the leaves of the oak and sycamore, the young shoots of which are so often tinged of a lively red, do not turn red in fading, but yellow, from which it may be inferred that the process of decay in leaves does not lead back to the same stage at which that of development commenced.

The autumnal purple colouration of leaves is met with in a few native plants, notably the bryony, the privet, and the dogwood. It imparts a dingy hue to the leaves, and is therefore not much noticed. I observed a case of its occurrence last summer, which I had not previously seen mentioned. Passing through a field of corn, which was then nearly ripe, I saw a number of plants by the sides of the path with blades distinctly purple. On closer observation it was evident that in all cases where this colouration occurred the ears of corn had been cut off before ripening, the act probably of idle passers-by, those plants which remained uninjured having become yellow as usual. I inferred that it was the injury sustained by the plant, and the arrest of its main function, that of the development of seed, that had led to the formation of some purple substance, not seen during the process of natural decay. I made some experiments on this purple colouring-matter, but all I can say about it is, that it belongs to the same class as the red and yellow colouring-matters of faded leaves. I anticipated the possibility of its being identical with a product of the decomposition of chlorophyll, crystallising in purple needles, which I had discovered in the course of my investigation, but I was disappointed in my expectation.

As regards the nature of the colouring-matters to which the various colours of faded leaves are due, opinions vary. It is generally supposed that they are formed from chlorophyll by some process of decomposition, probably of oxidation, and nothing can be more natural than this supposition. On exposure of the leaf to light and air, after its vital functions have ceased, the green colour due to chlorophyll gradually disappears and is succeeded by red, yellow, or purple. Therefore, it is argued, the respective colouring-matters must be derivatives of chlorophyll. Nevertheless, this view is open to some objection. As regards, in the first place, the red colouring-matter, since no one has succeeded in obtaining it artificially, it must be formed, if a derivative of chlorophyll, by some process not purely chemical. I have, indeed, obtained as one of the products of decomposition of chlorophyll a substance crystallising in red laminae, having a semi-metallic appearance by reflected light, but this substance is entirely distinct from the red colouring-matter of faded leaves.

The latter may easily be procured, at least in an impure state, by extracting the reddened leaves of the garden Azalea or the Virginia creeper with boiling spirits of wine, evaporating the extract at a gentle heat, and treating the residue with water, in which the colouring-matter dissolves. The solution has a fine crimson colour like that of red ink. The colour does not change on the addition of such acids as exert no oxidising action. Nitric acid gradually turns it yellow. By the addition of alkalies, such as ammonia, its colour changes to a yellowish green, and it has then very much the appearance of an alcoholic solution of chlorophyll, but it does not show either before or after the addition of alkali the least indication of absorption-bands, merely a general darkening of the more refrangible end of the spectrum. With lead acetate it gives a grass-green precipitate. These reactions show that the colouring-matter belongs to the same class as that of the rose and red flowers generally; but in the present state of our knowledge regarding this class of substances, it is quite impossible to say whether any two members belonging to the series are identical or not. One thing, however, is certain, viz., that the red colouring-matter of faded leaves is actually formed during the process of decay; it does not pre-exist in the green leaf, though there can be no doubt that leaves which are naturally more or less red, such as those of the copper beech and various species of colum, contain a ready formed red colouring-matter.

As to the yellow colouring-matter of faded leaves, whether it pre-exists in the green leaf or is formed from chlorophyll or some other leaf constituent, it is not so easy to pronounce a decided opinion. This colouring-matter, called by Berzelius *xanthophyll*, is supposed by some to be identical with phylloxanthin, the yellow substance which, according to Fremy and others, always accompanies the chlorophyll of green leaves. Of its properties little is known, and that little I find to be more or less incorrect. It is said to be soluble in alcohol and ether, insoluble in water, to turn green with acids, and to show a peculiar absorption-spectrum different to that of chlorophyll. These statements require correction. It is, in fact, soluble in water, but insoluble in ether; it does not turn green with acids, and the absorption-bands which it shows are due to an admixture of chlorophyll, as a few simple experiments are sufficient to show. Having taken some bright yellow elm leaves I extracted them with boiling spirits of wine, and obtained a greenish yellow liquid, which, after filtration, showed only the dark absorption-band in the red corresponding to band I. of the chlorophyll spectrum. I evaporated the extract in the water-bath, and during evaporation observed a deposit form on the sides of the dish consisting of green fat-like masses. On adding water to the residue, a portion dissolved, yielding a golden-yellow liquid, while the fat-like masses remained undissolved. After pouring off the liquid and washing the residue with water, the latter was dissolved in hot alcohol, when it gave a yellowish green liquid, which showed all the absorption-bands of chlorophyll distinctly. The golden-yellow watery solution, on the other hand, showed no trace of absorption-bands; merely a general darkening of the blue end of the spectrum. Its colour was evidently due to a yellow colouring-matter contained in it. It gave an abundant yellow precipitate with lead acetate, and a dark green precipitate with ferric chloride. It also contained a considerable quantity of tannin, since it yielded a thick curdy precipitate with gelatine, and an abundant deposit on the addition of a mineral acid. On again evaporating the solution in the water-bath, some decomposition evidently took place, for on adding water to the residue a quantity of matter in the form of brown powder remained undissolved. It is almost certain that it is the same process of decomposition going on in the yellow leaf on exposure to air and moisture that causes the colour to change to brown. I think it probable that the process is one of oxidation, and that it affects the tannin of the leaf or the solution rather than the yellow colouring-matter, for it is well known that

water solutions of tannin undergo decomposition, accompanied by change of colour from light to dark, on exposure to air, especially when the solutions are hot. This simple experiment shows that the yellow colour of faded elm leaves is due partly, perhaps chiefly, to a yellow colouring-matter soluble in water, partly to a yellowish green substance consisting essentially of chlorophyll. The former is, in my opinion, the true xanthophyll.

In order to gain, if possible, a little more insight into the process whereby the colour of green leaves changes to yellow, I took an alcoholic extract of fresh grass, which was of the usual bright green colour, and exposed it in a window to the action of the sun and air. After some days' exposure it had undergone the well known and frequently described transformation, i.e., the bright green colour had changed to a greenish yellow, and the solution from being opaque even in thin layers had become transparent in consequence of the oxidation of the chlorophyll contained in it. Now this liquid, though not quite so yellow as the alcoholic extract of faded elm leaves, was found closely to resemble the latter. On evaporating over the water-bath and adding water to the residue a yellow liquid was obtained, containing a colouring matter, the reactions of which were similar to those of the substance from elm leaves. No tannin, however, could be detected in the solution, and this may serve to explain the fact that blades of grass, corn, &c., do not ultimately become brown in fading, but remain yellow. The portion of the residue after evaporation left undissolved by water was green and fatty, and its solution in alcohol showed the absorption-bands due to modified chlorophyll.

These experiments leave the question of the nature and mode of formation of xanthophyll undecided. It may be one and the same substance in all leaves, or it may differ according to the source whence it is derived, it may be formed by the oxidation of chlorophyll, or it may pre-exist in the green leaf. I am inclined to think that it exists ready formed in the green leaf, but is not then seen on account of the far greater tinctorial powers of the chlorophyll present at the same time, and that it makes its appearance only when the chlorophyll has been decomposed, the sole trace left by the latter being the slight greenish tinge which all faded yellow leaves show more or less. The varying proportion of xanthophyll contained in green leaves would explain the fact, difficult to understand if we suppose it to be derived from chlorophyll, that some leaves assume a deep yellow colour in fading, while others remain of a pale yellow, and others again are almost colourless when they fall.

I will now conclude, hoping, if I have not communicated anything strikingly new, that I may at least have succeeded in affording the meeting a few moments' amusement.

PHILOSOPHICAL SOCIETY OF GLASGOW. CHEMICAL SECTION.

Annual Meeting, November 21, 1881.

Mr. E. C. STANFORD, F.C.S., Vice-President, in the Chair.

Mr. R. R. TATLOCK, F.C.S., was elected President of the Section in place of Mr. James MacGill, whose term of office had expired. Mr. Coleman and Dr. Dobbie were elected Vice-Presidents, and Mr. Arthur Wingate, Secretary.

Mr. COLEMAN, F.I.C., F.C.S., delivered an address on "*Recent Advances in the Production of Cold by Chemical Means.*" He explained the formula of Clausius and Sir Wm. Thomson regulating the performance of all machines for the production of cold, and showed that whatever vapour be used, whether air, ether, sulphurous acid gas, &c., the power required to produce a certain quantity of cold varies in the ratio of the range of cooling or difference between the absolute maximum temperature and the abso-

lute minimum temperature divided by the absolute minimum temperature, thus,—

$$C \frac{t_1 - t_2}{t_1}$$

where C stands for the heat units required to be abstracted; in the one case the energy derived from the coal used in driving the machine being applied directly to compressing the gas by pressure of its own vapour, and in the other case the energy of the coal being passed through the machine which drives the pump. This formula is, however, of little use in practice, without taking into account friction, the density of the vapour used, and its susceptibility to liquefaction. The ammonia machine is generally considered the most powerful, but the limit of its action where no pump is used is the boiling-point of the liquid ammonia, which is about 60° below freezing-point. In some recent ammonia machines, however, a pump is used, and consequently the liquid ammonia really evaporates into a vacuum, its boiling-point being reduced to fully 100° below freezing-point. But in practice these machines begin to lose efficiency long before the brine, being cooled, gets reduced to such low points, the evaporation being less and less rapid as the temperature sinks. For blowing into ships' holds and freezing meat for oceanic traffic, currents of air amounting to from 50,000 to 100,000 cubic feet per hour cooled 100° below freezing-point are required, so that the cooling of air by direct compression and expansion is now being generally preferred when the object is the cooling of air, and not of liquids. Upwards of forty such machines had been designed by the lecturer during the last three years, most of which are now in active use, and capable of freezing or of keeping frozen 200 to 250 tons of meat in a voyage from America or Australia to Great Britain.

NOTICES OF BOOKS.

Experimental Researches into the Properties and Motions of Fluids, with Theoretical Deductions therefrom. By WM. FORD STANLEY. London: E. and F. N. Spon.

WE have here the results of a prolonged series of experiments undertaken originally for the purpose of deciding whether the wave-motions of fluids were really suitable for illustrating those undulations of the ether which are supposed by the accepted theory of light. The author, however, finding that the conditions of the movements of fluids required further investigation, made them his main object, and he has arrived at certain conclusions differing from the generally accepted views on the laws of hydrodynamics. Thus in his second chapter he rejects the theory of *tensile* surfaces for liquids, as set forth by Segner now more than a century ago, and pronounces them instead *extensible*. The meanings which he attaches to these two terms may require explanation. By *tensile* he understands that condition of a surface in which its particles, like those of a stretched drum-skin, have a disposition to draw themselves together—a definition in effect the same as that commonly received. An *extensible* surface, on the other hand, he considers one whose parts have a disposition to separate from each other. He considers that the well-known experiment of a needle floating on the surface of water is in favour of his view. It is commonly considered that the needle does not sink because the particles of the surface of the liquid refuse to admit it between them. Mr. Stanley's interpretation of the phenomenon is as follows:—"If the surface of the water were already under tensile strain, as is now popularly concluded, it would then be clear that the weight of the needle would increase this tension, and unless the special cohesion of the surface were from some undefined cause very great the needle would immediately penetrate it. This would be illustrated by the instance generally offered of a stretched drum-skin ;

if this were stretched very tightly, a very moderate blow with a heavy body would break through it, but if it were loose or flabby it would resist a much greater blow, as the blow must be *plus the tension* present in the first case."

We submit that in this train of reasoning the author does not abide by the definition of "tension" which he has laid down above. If "tension" means a disposition of parts to draw themselves closer together it is clear that the weight of the needle will not increase but diminish this force, and must entirely overcome it before it can rupture the surface and penetrate into the liquid. On the contrary, if the particles of the surface have a disposition to part company—to remove away from each other—the needle ought at once to penetrate.

In the first chapter the author treats of the "construction of atoms forming fluids and other bodies," and lays down the proposition that:—"A simple gas is a fluid composed of atoms or the smallest divisible parts of matter, these atoms being infinitely tough and infinitely elastic bodies endowed with polar attractive forces by which they symmetrically unite." We must here remark that the term "atom" is, in virtue of its very etymology, applied to parts of matter which are indivisible. The author evidently, according to his language, considers matter as active *per se*, and not as merely actuated by external energy. He remarks—"Every known hard body has an elastic surface; if the atom has such a surface which deflects under pressure by some function of the pressure to the distance of surface impressed, or that the deflection is inversely as the square of the pressure, this deflection commencing upon contact by a quantity of pressure infinitely small. The pressures to the volumes of gases (The relation of the pressures to the volumes of gases, &c. ?) could as well be accounted for by this means as by any other, without the necessity of supposing the atom to possess propulsive forces or to act where it is not." If we rightly understand this passage it amounts to a rejection of the kinetic theory of gases. The author proceeds:—"There is no physical reason to assume the atom being infinitely hard, as is general: in assuming it infinitely tough and elastic this would equally ensure its permanent durability; or it might possess an infinitely hard nucleus and an infinitely elastic surface, which I think is most probable." In these last lines, therefore, we have the atom presented to us at least ideally divisible, consisting of two layers, and endowed with different properties. We find that on the previous page Mr. Stanley remarks that every known hard body has an elastic surface. Here, therefore, he regards hardness and elasticity as by no means incompatible, though it might be asked why should elasticity be ascribed to the surface only of bodies? Yet a little further we read:—"It is possible that heat may be the entire cause of the surface elasticity of the atom, as just proposed. The atom being without this force infinitely hard and infinitely attractive to other atoms; this is consistent with the known properties of chemical attraction and of heat to separate atoms, that is, to expand matter." We have always, in common with other chemists, supposed that the properties of chemical attraction are not to separate but to unite atoms. We cannot help suggesting that the first chapters, which the author admits are "speculative and even in parts hypothetical" stand in need of reconsideration.

On page 314 the author describes and figures a curious experiment. If a tall narrow-glass trough is filled with water, and a pen full of ink is gently applied to the surface of the liquid, the ink, in descending, divides into a double stream, each of which again bifurcates, and so on till we have the resemblance of an inverted tree. We have seen somewhat similar phenomena when a heavier liquid is dropped very gently into one of less specific gravity. Something similar may be witnessed in the action of precipitants upon various solutions. It is possible that this phenomenon may repay investigation. The author's explanation is that the ink, descending slowly by gravitation, "will be found to divide constantly upon the conic resist-

ance which opposes its direct projection." But supposing resistance acting in directions corresponding to the outlines of a cone, we do not see why bifurcation should ensue. We should rather expect that the descending stream would divide into three.

On page 339 we notice a statement which is no longer strictly correct. Water is now known not to be the only body which becomes lighter on solidification. A rod of grain bar tin, coiled up in a flat spiral, will float upon a bath of molten tin and zinc exhibits a similar phenomenon.

OBITUARY.

ROBERT CALVERT CLAPHAM, F.C.S.

MR. CLAPHAM, a well-known chemist, of Earsdon House, near Newcastle-upon-Tyne, died at Winchelsea, on the 22nd December, 1881, aged 58 years. He was elected a Member of the Society of Arts in 1874, and he has been since that time a frequent attendant at the meetings and a speaker in the discussions. He was appointed examiner on the Alkali Manufacture in the Technological Examinations of the Society of Arts, when in 1875 this subject was first added to the programme of examinations. When the City and Guilds of London Institute took over the Technological Examinations of the Society, Mr. Clapham continued as Examiner to the new institution. Mr. Clapham was the author of several papers on chemical and chemico-geological subjects in various scientific journals, both alone and with other writers. The first of these was on the "Theory of the Formation of Sulphur in Volcanic Countries," published in the "Transactions of the Tyneside Naturalists' Field Club" (iv., 1858-60). Other papers appeared in the Reports of the British Association, in the *CHEMICAL NEWS*, *Geologist*, and other journals.

CORRESPONDENCE.

THE NEW ALKALOID—HOMO-QUININE.

To the Editor of the Chemical News.

SIR,—The note of Messrs. Wood and Barret (*CHEMICAL NEWS*, vol. xlv., p. 6) does not explain the new alkaloid (homo-quinine) lately described by three independent papers, as all who have found it agree that the neutral sulphate re-crystallises unchanged from water, in which it is less soluble than quinine sulphate, and the mother-liquor from the re-crystallisation does not show the presence of quinidine when tested by the usual methods.—I am, &c.,

DAVID HOWARD.

Stratford, near London, E., Jan. 9, 1882.

SECONDARY BATTERIES.

To the Editor of the Chemical News.

SIR,—Finding that you have printed Prof. Adams's paper on "Secondary Batteries," we should be obliged if you would kindly inform your readers that the paper may be obtained in pamphlet form from the Secretary of the Science Society, King's College, Strand, W.C., post free, 6d.—I am, &c.,

WALTER G. McMILLAN, Pres.

King's College Science Society,
January 10, 1882.

Use of Salicylic Acid.—M. Pasteur considers that the use of salicylic acid in articles of human consumption is permissible, but that its presence and exact proportion should always be declared.—*Moniteur Scientifique*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 24, December 12, 1881.

Methods of Comparing the Coefficients of Induction.—M. Brillouin.—This paper does not admit of useful abstraction.

Specific Heats of Gases at Elevated Temperatures.—MM. Mallard and Le Chatelier.—The authors have determined the specific heats of carbonic acid, watery vapour, nitrogen, oxygen, carbonic oxide, and hydrogen, at temperatures about 2000°. In case of carbonic acid dissociation began to be manifested about 1800°; watery vapour and carbonic oxide showed no appreciable traces of dissociation, even at temperatures exceeding 2000°. The specific heat of carbonic acid increases with the temperature at least up to 2000°, but the rate of increase diminishes. The specific heats of hydrogen, nitrogen, oxygen, and carbonic oxide are equal to each other at 2000°, as they are at 0°.

Solubility of Barium and Strontium Sulphates in Concentrated Sulphuric Acid.—MM. Varenne and Pauleau.—As regards barium sulphate, whatever are the masses of saline solution brought into play, the coefficient of solubility seems constant. The precipitate obtained from the nitrate is twice as soluble in sulphuric acid as that thrown down from the chloride. The solubility of strontium sulphate is likewise constant, whatever the masses employed. On comparing the coefficients of solubility of the two sulphates it appears that they are approximately proportionate to the equivalents of the bases.

Direct Process of Coppering Cast-Iron, Wrought-Iron, and Steel.—The author dispenses with the use of potassium cyanide, for which he substitutes organic acids or glycerin. The baths serve continuously if fed with copper oxide. The well-known power of alkaline organic solutions to dissolve easily and quickly iron oxides without attacking the metal, renders it easy to clean the objects to be coppered. One method consists in plunging the articles into the bath in contact with zinc wires. The coppering takes place instantly. Or in the vat containing the alkaline organic solution of copper and the objects to be coppered are placed porous vessels filled with soda-lye, in which are plates of zinc connected to the articles to be coppered by means of a thick copper wire. The third method consists in coppering the articles, of whatever thickness, by means of the same baths and a dynamo-electric machine. Nickel, cobalt, antimony, tin, &c., may be deposited upon iron in a corresponding manner.

Pocket Battery with Jointed Elements.—M. Pulvermacher.—A portable apparatus for medical use.

Decomposition of Metallic Formiates in Presence of Water.—J. Riban.—The salts of potassium and sodium are not decomposed at the temperature employed; that of barium is also unaffected. In the salts of the magnesian series an incipient decomposition is traced. In the salts of iron, &c., metallic oxide is set at liberty, and the formic acid is partially decomposed with development of hydrogen, carbonic acid, and traces of carbonic oxide.

No. 25, December 19, 1881.

Observations on the Decomposition of the Metallic Formiates in Presence of Water.—M. Berthelot.—This memoir does not admit of useful abstraction.

The Principle of Surfaces of Separation.—M. Berthelot.—M. Lemoine contends that he had announced this principle prior to M. Berthelot, viz., in 1871. The latter, however, set forth the same principle as early as 1862, in his "Researches on Ethernification."

Researches on the Fundamental Laws of Electrodynamics.—P. le Cordier.—This memoir is purely mathematical, and comprises two parts. The object of the first part is to establish the laws, discovered by Ampère, of the action of a closed fixed and permanent linear current upon an element of current, fixed and permanent, which does not form part of it, and to connect therewith the study of all the ponderomotor forces observable upon this same element, and upon a fixed and permanent magnet exterior to the acting system, which must exclude closed, fixed, and permanent currents, fixed and permanent magnets, and terrestrial magnetism. The second part of the memoir contains a brief exposition of the hypotheses of Ampère and Grassman upon the mutual action of two elements of currents.

Lippmann's Method for the Determination of the Ohm.—M. Brillouin.—The author concludes that the method of M. Lippmann measures a quantity absolutely unknown. The phenomena due to the capacity of the wire cannot be generally neglected, but with the particular dimensions indicated in the paper of Dec. 5th, it is possible that the method may furnish an exact determination of the ohm.

History of the Process employed in the Direct Coppering of Cast-Iron.—F. Weil.—The author makes a claim to priority as against M. Val d'Osne.

Diffusion of Solids into Solids.—A. Colson.—The author gives several instances of this phenomenon. Thus if a plate of iron is heated in lamp-black in a reducing atmosphere, not merely the carbon passes into the iron, transforming it successively into steel and cast-iron, but notable quantities of iron become diffused in the charcoal. He concludes that this mutual diffusion only happens in case of bodies which have an affinity for each other.

Combustion-Temperature and the Dissociation of Carbonic Acid and of Watery Vapour.—MM. Mallard and Le Chatelier.—The results are given in the form of tables.

Potassium Chromo-cyanide.—H. Moissan.—The author obtains this compound by the action of potassium cyanide upon a solution of chromium protochloride, or by heating to 100° in a sealed tube chromium ground up with a concentrated solution of potassium cyanide, or by the action of potassium cyanide upon chromous carbonate. Potassium chromocyanide appears in fine yellow crystals. Its specific gravity is 1.71. It has no action upon polarised light. The saturated solution examined with the spectroscope at the thickness of 0.15 metre shows a total absorption of the violet, a less absorption of the blue, and three very visible bands in the green. The salt is anhydrous and permanent in the air at common temperatures. Under the action of an electric current its solution gives chromi-cyanide at the positive pole, and hydrogen and potassa at the negative. Its physiological action is similar to that of potassium ferrocyanide, which it closely resembles by the generality of its characters.

Decomposition of Metallic Formiates in Presence of Water: Production of Certain Crystalline Minerals.—J. Riban.—The formiates in question are those of copper, mercury, and silver.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 14, 1881.

The Telephone and Telluric Currents.—M. Dufourcet.—The author has in his court two bars of iron planted in the earth, to each of which is fixed a conductor of coated copper wire terminating in his receiver. These he consults two or three times daily, and they never fail to give notice twelve to fifteen hours in advance of every storm which bursts over the town.

No. 14, 1881.

The Abbé Moigno complains, in an able article, of the treatment which M. Tommasi has recently experienced in

MISCELLANEOUS.

Firth College.—We are glad to learn that the number of students who have entered the Chemical Laboratory of the College this session has been so great that the present accommodation has been quite insufficient. The Council, therefore, decided at their last meeting to erect working benches for sixteen more students. The University of Edinburgh has recently recognised Dr. Carnelley, Professor of Chemistry in Firth College, as a teacher of medicine in Sheffield, whose Lectures on Chemistry and Course of Instruction in Practical Chemistry shall qualify for Graduation in Medicine in that University. The Lectures on Chemistry and Laboratory Practice at Firth College have also been recognised by the Royal College of Surgeons and the Royal College of Physicians.

MEETINGS FOR THE WEEK.

- MONDAY, 16th.**—London Institution, 5.
Medical, 8.30.
TUESDAY, 17th.—Institute of Civil Engineers, 8.
Pathological, 8.30.
Royal Institution, 3. "The Mechanism of the Senses," Prof. J. G. M'Kendrick.
WEDNESDAY, 18th.—Society of Arts, 8. "The Relation of Botanical Science to Ornamental Art," by F. Edward Hulme, F.L.S., F.S.A.
Meteorological 7. Anniversary.
THURSDAY, 19th.—Royal, 4.30.
Royal Society Club, 6.30.
Royal Institution, 3. "Corals," Mr. H. N. Mosely.
Chemical, 8. "Researches into the Chemistry of Bast Fibres," C. F. Cross and S. J. Bevan. "On Dibenzoyl Aniline and its Isomerides," by A. Higgins. "A New Apparatus for Determination of Melting-points," by C. F. Cross and S. J. Bevan. "Contributions to the History of Cerium Compounds," by W. N. Hartley.
FRIDAY, 20th.—Royal Institution, 8. "Comets," Dr. W. Huggins, 9.
SATURDAY, 21st.—Royal Institution, 3. "Louis van Beethoven," by Prof. Pauer.

TO CORRESPONDENTS.

H. Hudson.—If you try the experiment you will find that similar magnetic poles repel, whilst opposite poles attract.

TO CHEMICAL MANUFACTURERS, &c.

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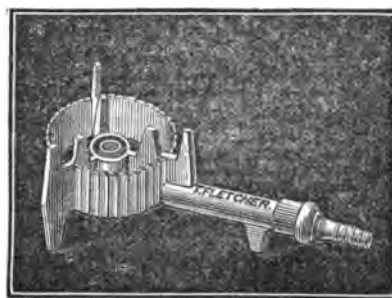
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ANALYSIS BY JOHN PATTINSON, ESQ.

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THE CHEMICAL NEWS

VOL. XLV. No. 136.

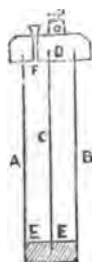
23 JAN 82

ON A
NEW ELECTRICAL STORAGE BATTERY.
(SUPPLEMENTARY NOTE.)

By HENRY SUTTON.

THE new cell consists of a flat copper case, same shape as a Grove's cell; it has a lid of paraffined wood, from which hangs a plate of lead amalgamated with mercury, the lower part of lead plate being held in a groove in a slip of paraffined wood resting on bottom of copper case; through the lid a hole is bored for introduction of solution, which consists of a solution of cupric sulphate, to which is added one-twelfth of hydric sulphate; the presence of this free sulphuric acid improves the cell at once.

The following sectional sketch shows the arrangement:—



A B, the outer flat copper case.

C, plate of amalgamated lead held in grooves in cap D and slip E. F shows the hole in cap through which the solution is introduced, and by the introduction of a glass tube through this hole the state of the charge is seen by observing the colour; the interior surface of the case forms the negative electrode, and the amalgamated lead the positive.

ON THE VARIATION OF THE
ELECTRIC CONDUCTIVITY OF GLASS WITH
TEMPERATURE, DENSITY, AND CHEMICAL
COMPOSITION.†

By THOMAS GRAY, B.Sc., F.R.S.E.

IN this paper the results of the continuation of a series of experiments, some preliminary results of which were published in the *Phil. Mag.* for October, 1880, are given. The experiments were performed in the Physical Laboratory of the Imperial College of Engineering, Tokio, Japan.

In the preliminary experiments it was found that the conductivity of glass increased with the temperature, following a similar law to that found to hold for other highly insulating substances. It was also found that the effect of successive heatings and coolings was to diminish the conductivity. Further experiments on this subject show that, although the diminution of conductivity here referred to sometimes occurs, it does not always occur, and does not seem to do so when the glass is newly manufactured. Reference is made to preliminary experiments on the effect

of time on the electric conductivity of glass, the results of which indicate an increase in conductivity with time.

The subject of the main part of the paper is an account of experiments on the relation between the electric conductivity of glass and its density and chemical composition. A large number of specimens of lime glass were examined, but, as was to be expected in this case, no marked connexion between electrical quality and density could be observed. It was found, however, on analysing a few specimens, that the composition of those which had a high conductivity differed considerably from that required to form an exact chemical compound, whilst those which had a low conductivity had a composition agreeing more or less closely with that required for a trisilicate of potash and lime or a mixture of potash, lime, and soda-lime trisilicates.

A few specimens of lead or flint glass were examined in the same way, and in this case a very marked connexion between electric conductivity and density was observed. This result was, however, no doubt due to the fact that the density of this kind of glass gives an indication of its chemical composition. In all the specimens examined it was found that the higher the density the lower the conductivity. The highest density reached, however, was that in the case of a Thomson's electrometer jar, which had a density of 3.172. On examining these specimens for chemical composition it was found that the electrometer jar contained almost exactly the proper amount of lead and potash to form a trisilicate of potash and lead. It appears likely, therefore, that the electric conductivity of glass is lowest when it is an exact chemical compound. It will be interesting to learn from future experiments if still more dense glass has a higher conductivity, and if the conductivity passes a minimum at the point where the pure silicate is reached.

The author has to express his great obligation to his colleague, Dr. Edward Divers, in whose laboratory and under whose superintendence the chemical analyses of the specimens of glass were made.

QUANTITATIVE DETERMINATION OF UREA
BY ALKALINE HYPOCHLORITES
AND HYPOBROMITES.

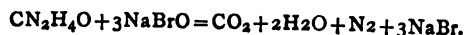
By THEO. G. WORMLEY, M.D.,

Professor of Chemistry in the University of Pennsylvania.

THE determination of the amount of urea present in the urine by the volume of nitrogen evolved under its decomposition by sodium hypochlorite was first proposed by Davy (*Phil. Mag.*, 1854, p. 385). According to his observations, the quantity of nitrogen evolved corresponded very closely to the calculated amount present in the urea. But according to the observations of M. Leconte (*Chem. Gaz.*, 1858, 433), with a different form of apparatus, under the action of this reagent only about 92 per cent of the nitrogen is evolved.

Messrs. Russell and West proposed to substitute for the hypochlorite an alkaline solution of sodium hypobromite, and advised a special form of apparatus for the application of the test (*Jour. Chem. Soc.*, Aug. 1874, and *Am. Jour. Med. Sci.*, April, 1875, p. 531). These observers, however, obtained only about 94 per cent of the total nitrogen.

Under the action of either of these reagents, as is well known, the urea is resolved into carbon dioxide, water, and free nitrogen, thus:—



Theoretically, therefore, the whole of the nitrogen should be evolved, but it is generally admitted that in practice this is not the case. According to at least one observer, this loss is due to a portion of the nitrogen being retained as a cyanate; whilst according to another it is retained as a nitrate.

* A Paper read before the Royal Society, January 12, 1882.

† Abstract of a Paper read before the Royal Society, Jan. 12, 1882.

To remedy this defect, M. Mehu advised to mix either glucose or cane-sugar with the urine before adding the hypobromite, when the whole of the nitrogen would be set free (*Comptes Rendus*, 1879, 175). But, according to M. Esbach (*Ibid.*, 417), and also to M. Jay (*Bull. Soc. Chim.*, 1880, 105), a solution of glucose *alone* evolves some gas under the action of the reagent. Again, M. Fauconnier obtained in the presence of glucose, from a given quantity of urea, the theoretical amount of nitrogen; whilst in the presence of cane-sugar he obtained only 94 per cent of the total nitrogen (*Ibid.*, 102).

According to my own experiments, when a solution either of cane-sugar or of glucose is mixed, at least in certain proportions, with the hypobromite reagent, without the presence of urea, the temperature of the mixture increases and its yellow colour is gradually discharged, but *no gas is evolved*. When 1 grm. of cane-sugar in 5 c.c. water was added to 10 c.c. of the reagent (prepared as stated hereafter) at 21.1° C. (70° F.), the mixture at the end of twenty-five minutes acquired a temperature of 30° C. (86° F.), after which the temperature slowly fell.

In a similar experiment with glucose, the temperature increased from 21° C. (69.8° F.) to 35.5° C. (96° F.) in ten minutes, which was the maximum reached. It was also observed that the presence of large excess of glucose entirely prevented the decomposition of urea by the hypobromite reagent.

For the purpose of examining the accuracy of this test for urea, without the presence of cane-sugar or glucose, the form of apparatus, at least in principle, advised by R. Apjohn (*Chem. News*, vol. xxxi, p. 37), was employed. This consists of a wide-mouthed bottle in which is placed the reagent, and also a small test-tube, for containing the urea solution, of about 10 c.c. capacity and of such length as to stand inclined in the bottle. The mouth of the bottle is closed with a rubber stopper carrying a glass tube, by which it is connected by rubber tubing to a graduated burette divided into one-tenth c.c. and suspended in a long cylinder of water from an adjustable arm.

The urea solution is placed in the small tube within the charged bottle, the apparatus closed, and when there is no longer any change in the height of the column of liquid within the graduated tube, this is so adjusted that the surface of the contained liquid exactly coincides with that in the cylinder. This point, the temperature, and in exact experiments the barometric pressure, being noted, the urea solution is mixed with the reagent by inclining the bottle and gently shaking the mixture. As the evolved nitrogen collects in the graduated tube, the latter is gradually raised to relieve the contained gas from the increased pressure. When the evolution of gas has entirely ceased and there is no longer any change in the volume of gas, the tube is finally adjusted and the exact volume noted. The reagent employed was prepared, as first advised by Messrs. Russell and West, by dissolving 100 grains caustic soda in 250 c.c. water, and adding to the cooled mixture 25 c.c. bromine. In applying the reagent it was diluted with a volume and a half of pure water.

With this arrangement a series of experiments was performed employing 1 c.c. of a standard solution of pure urea varying in strength from one to six per cent, variously diluted, and added to varying quantities of the reagent. These experiments gave different results, in some only about 90 per cent, and even less, of the nitrogen being evolved, while in others a larger proportion was obtained, and in still others the *whole* of the nitrogen was set free. It was finally observed that under certain conditions the whole of the nitrogen is uniformly eliminated. These conditions are:—

1. The reagent should be freshly prepared.
2. The urea solution should be wholly added to the reagent, none of the latter being allowed to mix with the urea solution in the containing tube.
3. The amount of urea operated upon should not exceed one part to about twelve hundred parts of the diluted reagent.

Moreover, the diluted urea solution should be added in small portions at a time to the reagent, thoroughly mixed, and the effervescence allowed to cease before any further addition of urea. So, also, it would appear, at least when comparatively large quantities of urea are present, that the surrounding temperature should not be less than about 20° C. (68° F.).

In the practical application of the test, if a 2 per cent solution of urea is under examination, 1 c.c. of the solution, diluted with from 5 to 10 c.c. water, is placed in the containing tube, and the mixing bottle charged with 10 c.c. of the reagent diluted with 15 c.c. water; whereas, for 1 c.c. of a four per cent. solution of urea, similarly diluted, not less than about 50 c.c. of the diluted reagent should be employed.

In a final series of experiments, in which the above conditions were observed, the temperature being noted to one-tenth of a degree, and the results reduced to the standard temperature (0° C.) and barometric pressure (760 m.m.), the following average results were obtained:—

Urea employed.	Nitrogen evolved=
10 milligrammes	9.98 m.grm. urea.
20 "	20.07 "
30 "	29.95 "
40 "	39.88 "

In these experiments it was assumed that 1 gramme of urea contains 372 c.c. of nitrogen, measured at 0° C. and 760 m.m. barometric pressure; or, that each c.c. of nitrogen evolved, measured under the conditions stated, represented 0.002688 gramme urea.

During these investigations it was observed, in cases in which the whole of the nitrogen was not evolved, that so long as the conditions remained the same, the relative proportion of the nitrogen eliminated was pretty uniform. Hence, if the volume of nitrogen evolved from a known quantity of urea under certain conditions, or by a given form of apparatus, be determined, the result may be taken as the basis for the determination of the urea in the urine with sufficient accuracy for clinical purposes.—*American Journal of the Medical Sciences*.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING DECEMBER 31ST, 1881.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

January 3rd, 1882.

SIR,—In this, our twelfth monthly report, we lay before you the results of our analyses of the 180 samples of water collected by us during the month of December, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 180 samples, one was recorded as "slightly turbid," and 15 as "very slightly turbid." The remaining 164 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from December 1st to December 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole, excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Grand Junction Company, 4 were found to be "very slightly turbid," the remainder being well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, one was recorded as "slightly turbid," seven as "very slightly turbid," and eighteen as well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

As was to be expected from the observations of many previous years, the amount of organic carbon in the water, together with the degree of its colour, is appreciably in excess of that present during the Summer and Autumn. There is not, however, any increase in the proportion of nitrate and chlorides, or any decrease in the proportion of dissolved oxygen.

We are at present engaged in preparing a Report, in which we shall endeavour to place before you as a whole the results of the analyses made by us during the past year.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

RESEARCHES ON THE COMPLEX INORGANIC ACIDS.*

By WOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

PHOSPHO-MOLYBDATES.

THE application of molybdic oxide to the separation and estimation of phosphoric acid has given a special interest to the phospho-molybdates, and they have accordingly been studied more or less completely by several chemists. The most thorough investigations which we possess are those of Debray,[†] Rammelsberg,[‡] and Finkener,[§] but particular salts have been examined by others, and these will be noticed under the appropriate special headings.

Phospho-molybdates appear to be formed whenever phosphoric acid or a soluble phosphate is brought in solution with a molybdate, the presence of a free acid not being essential. They are also formed when phosphates and molybdates are fused together, when molybdates insoluble in water are dissolved in phosphoric acid, when molybdic oxide is digested with an alkaline phosphate,

and when insoluble phosphates and molybdates are treated together with a dilute acid. As a class they are better defined and more easy to obtain pure than the phospho-tungstates, which in many respects they closely resemble. When phospho-molybdates of fixed alkaline bases are heated, they at first give off water of crystallisation, and by careful heating may be obtained anhydrous. In some cases, however, molybdic oxide is volatilised even from salts containing fixed alkaline bases. I did not succeed in obtaining well-defined pyro-phospho-molybdates or pyro-phospho-tungstates, though of course the residues of the ignition of the acid salts may be regarded as such. When a phospho-molybdate is dissolved in ammonia-water and a current of sulphydric acid gas is passed into the hot solution, sulpho-molybdates are formed in large quantity. This reaction distinguishes the phospho-molybdates from the phospho-tungstates, which are not decomposed under the same circumstances.

Analytical Methods.—The determination of the sum of the percentages of molybdic and phosphoric oxides was usually effected, as in the case of the phospho-tungstates by precipitating the two oxides together by mercurous nitrate, with addition of mercuric oxide to neutralise the free nitric acid. It is best to precipitate from a boiling solution, and to boil for a short time after adding mercuric oxide. This last must always be in small excess. On account of the volatility of molybdic teroxide, it is not possible to determine directly the sum of the weights of the two oxides by simple ignition, but the difficulty may be readily overcome by the following process:—The filter with the mercurous salts is to be cautiously heated in a platinum crucible properly inclined to the vertical axis of the flame until the filter is completely carbonised. On then regulating the heat and the supply of air, the carbon may be readily burned off, leaving a mass of mercurous salts mixed with more or less mercuric oxide, no weighable amount of molybdic teroxide being lost. An accurately weighed quantity of anhydrous normal sodic tungstate in fine powder is then to be added, and the contents of the crucible carefully mixed together with a stout platinum wire previously weighed with the crucible itself. The whole is to be heated at first by radiation from a small iron dish, and afterwards directly, until a clear white fused mass is obtained. A second ignition and second weighing will determine whether every trace of mercury has been expelled. It is almost needless to remark that all these operations must be conducted under a flue with a good draught. This process gives excellent results, and is much less tedious than would perhaps be supposed.

After the estimation of the phosphoric oxide, the molybdic teroxide is best determined by difference from the sum of the weights of the two oxides found as above. No really good general method for the quantitative separation and estimation of molybdic oxide has yet been given, at least no one which is sufficiently accurate to serve as a check upon the method above described. The ammonium salts of this series are most simply analysed by igniting them directly with sodic tungstate, when the loss of weight corresponds to the sum of the water and ammonia.

As in the case of the phospho-tungstates, the quantitative determination of the phosphoric oxide is a matter of considerable difficulty. The method of separation by means of magnesia-mixture has been carefully studied by Dr. Gooch, to whose paper I have already referred.* Dr. Gooch found it necessary to precipitate the ammonio-magnesian phosphate a second time, a single precipitation giving an error amounting sometimes to 6 or 7 per cent of the phosphoric acid present. After re-solution and precipitation by ammonia, the mean error amounted to only 0.65 per cent, which makes an almost insensible correction when the quantity of phosphoric oxide is small. In a few instances I have applied this correction after a double precipitation, but I prefer to employ the following method, which gives an almost perfect separation from molybdic

* *Proceedings of the American Academy of Arts and Sciences.*
Communicated by the Author.

† *Bull. Soc. Chim.*, 2, 404.

‡ *Berichte der Deut. Chem. Gesell.*, 10, 1776.

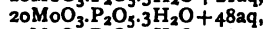
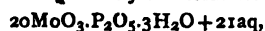
§ *Ibid.*, 11, 1638.

* *Proceedings of American Academy*, 15, 53.

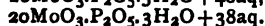
teroxide. The phosphoric oxide is first precipitated from a hot solution as ammonio-magnesian phosphate, the supernatant liquid after complete subsidence carefully decanted upon an asbestos filter, the precipitate washed with magnesia-mixture and ammonia, then re-dissolved in the least possible quantity of hot dilute chlorhydric acid and re-precipitated with ammonia. After complete subsidence and decantation, the precipitate is boiled with successive portions of a solution of ammoniac sulphide. A more or less dark orange-red solution of ammoniac sulpho-molybdate is always obtained at first, but after two or three repetitions of the process the ammoniac sulphide added remains colourless on heating. The ammonio-magnesian phosphate is then filtered upon the asbestos filter already employed. In place of this method I have sometimes employed the following modification, which gives, I think, equally good results. After the first precipitation the phosphate is to be re-dissolved, and the hot solution precipitated at once by ammoniac sulphide in excess. The precipitated phosphate is then to be boiled two or three times with ammoniac sulphide as above. Whatever inaccuracy is inherent in this method depends, in my judgment, upon the fact that, as Dr. Gooch has shown, the determination of phosphoric acid by means of magnesia is, under the most favourable circumstances, a less accurate process than has been supposed.

The determination of ammonia and the alkalis was effected by the methods already described in the case of the phospho-tungstates. Water must be estimated by ignition with sodic tungstate, as there is often volatilisation of molybdic teroxide when a phospho-molybdate is ignited at a temperature sufficient to expel its water. The analyses require great care and no small amount of practice to ensure good results. As in the case of the phospho-tungstates, the alkaline bases are best determined by difference.

Twenty-four Atom Series.—Phospho-molybdic acid. The acid of this series was first obtained by Debray, who prepared it by boiling ammoniac phospho-molybdate with nitro-muriatic acid, and allowing the solution to evaporate spontaneously. I find that this is a good method of obtaining the acid, but the following details should be observed. The bright yellow ammoniac phospho-molybdate should be first dried, and then heated with a large excess of strong aqua regia in a casserole over an iron capsule to serve as a radiator. In this manner the decomposition proceeds very regularly and without successions. When it becomes necessary to add fresh acid, the supernatant liquid should be allowed to settle completely and then be poured off carefully. Fresh acid may then be added, and the process, which is at best a slow one, continued. When the ammonium salt has disappeared, the liquid is to be evaporated until the excess of nitric and chlorhydric acids has been expelled. On standing, large bright yellow octahedral crystals are obtained from the very concentrated solution. These may be re-dissolved and re-crystallised, but there is always some loss in the process of purification, because solution in water produces more or less decomposition of the acid, with formation of a pale greenish white crystalline body. This substance passes very readily through a filter, and the solution of the acid must be allowed to settle completely before the clear supernatant liquid is brought upon the filter. Debray obtained three different hydrates of phospho-molybdic acid, to which he gave respectively the formulæ—



and

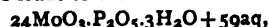


Unfortunately he has not given either the methods or the complete results of his analyses. In the first hydrate he found 13.30 per cent, in the second 23.40 per cent, and in the third 19.60 per cent of water.

I obtained the acid only in transparent octahedral crystals which had a bright yellow colour. Of these crystals, dried by pressure with woollen paper :—

0.9945 grm. lost by ignition with WO_3Na_2 0.2362 grm. = 23.75 per cent water.
1.4588 grm. gave 0.0713 grm. P_2O_5 , $\text{Mg}_2 = 3.12$ per cent P_2O_5 .

The analysis leads to the formula—



which requires :—

		Calc.	Found.
24MoO_3	..	3456	73.31
P_2O_5	..	142	3.01
$62\text{H}_2\text{O}$	..	1116	23.68
		4714	100.00

The phosphoric oxide was determined by double precipitation and treatment with ammoniac sulphide. The molybdic oxide was estimated by difference. The crystallised acid effloresces so readily that the precise determination of the water is difficult. In a portion of the crystals which had effloresced in a very marked degree—

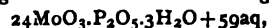
0.9873 grm. lost on ignition with WO_3Na_2 0.1760 grm. = 17.82 per cent water.

2.2472 grms. gave 0.1163 grm. P_2O_5 , $\text{Mg}_2 = 3.31$ per cent P_2O_5 .

The ratio of the molybdic to the phosphoric oxide is, in this analysis, also 24 : 1 ; and, if we compute the results of both analyses for an anhydrous compound of the two oxides, we find—

		Calc.		
24MoO_3	..	3456	96.06	95.91
P_2O_5	..	142	3.94	4.06
		3598	100.00	100.00

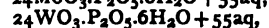
The analyses leave, I think, no reasonable doubt as to the ratio of the two oxides. Phospho-molybdic acid therefore corresponds in composition with phospho-tungstic acid, the ratio of the two oxides being 24 : 1, as given by Finkener,* and not 20 : 1, as stated by Debray. With respect, however, to the number of atoms of water in the crystallised octahedral hydrate, I may remark that, while the analysis agrees best with the formula given,—



it is much more probable that the acid really contains an atom less of water, and that its formula, apart from the question of basicity, is—



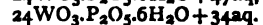
like



already described. This formula requires 23.38 per cent water, instead of 23.75 per cent, as found. Debray found 23.40 per cent. As already stated, the crystals analysed were dried by pressure with woollen paper after draining off a syrupy mother-liquor, and may therefore not have been perfectly free from extraneous water. Finally, the analyses of Finkener led also to the formula with 61 atoms of water, and I shall adopt this as the definite constitution of the octahedral hydrate. Finkener's work has not yet been published in detail ; but, from the abstract which he has given, it clearly appears that we owe to him the establishment of the true constitution of the only phospho-molybdic acid yet obtained. As already mentioned, there are two other hydrates of phospho-tungstic acid having respectively the formulæ—



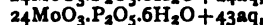
and



The two hydrates of phospho-molybdic acid described by Debray would correspond to the formulæ—



and—

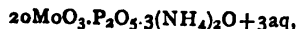


if we suppose them, as is most probable, to belong to the 24-atom series. The first formula requires 13.05 per cent,

the second 19.66 per cent water. Debray found 13.09 per cent and 19.60 per cent. Finkener obtained still another hydrate, containing about 32 atoms of water, basic water included.

Phospho-molybdic acid dissolves very readily in water, forming a colourless liquid which has a strong acid reaction. As already stated, the solution is always accompanied by a slight decomposition, with formation of a very pale greenish white crystalline substance. A precisely similar decomposition is observed in the solution of the corresponding phospho-tungstic acid. The crystals lose all their water when slightly ignited. According to Finkener, three atoms of water remain at 140° C. The solution readily expels carbonic dioxide from the alkaline carbonates. The question of the basicity of the acid will be discussed farther on.

24 : 3 Ammonic Phospho-molybdate.—The constitution of the beautiful yellow salt which is formed when an excess of a mineral acid is added to a solution containing molybdic and phosphoric oxides and a salt of ammonium, has long been in dispute. The analyses of Svanberg and Struve,* Nutting,† Sonnenschein,‡ Lipowitz,§ and Seligsohn,|| gave results which differed very sensibly from each other, according to the method of analysis employed. Debray gave the formula—



but without the details of his analysis. More recently the subject has been examined with great care by Finkener,¶ who has arrived at the conclusion that, though the percentages of water and ammonia may vary within wide limits, the ratio of the molybdic and phosphoric oxides is always as 24 : 1.

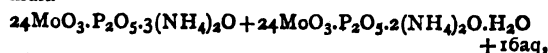
With respect to the preparation and properties of the yellow ammonium salt, I have little to add to what has been done by these chemists. I repeatedly prepared the salt for analysis, usually by mixing solutions of ammonic molybdate—7 : 3 salt—and phosphate, adding nitric acid in excess to the solution, and boiling. When the mixed solution is boiled for a short time, the precipitation of the yellow salt is complete after standing until the liquid becomes cold. In the publication of this result, which is important in analysis, I have been anticipated by Atterberg** ; but I propose in another paper to give the results of my work on the quantitative determination of phosphoric acid, and will then give ample details.

As regards the composition of the yellow phospho-molybdates of ammonium, my results do not agree with those of Finkener, as I think I have evidence that, as in the case of the phospho-tungstates, there are series of phospho-molybdates in which the ratio of the molybdic to the phosphoric oxide is an 20 : 1, as 22 : 1, and as 24 : 1. In one preparation—

1.1492 grm. lost on ignition with WO_4Na_2 0.0827 grm. NH_3 and H_2O = 7.20 per cent.
0.5905 grm. lost on ignition with WO_4Na_2 0.0432 grm. NH_3 and H_2O = 7.31 per cent.
1.7158 grm. gave 0.1027 grm. P_2O_5 $\text{P}_2\text{O}_5/\text{Mg}_2$ = 3.83 per cent
0.9806 grm. gave 0.0567 grm. P_2O_5 $\text{P}_2\text{O}_5/\text{Mg}_2$ = 3.70 per cent
1.8903 grm. gave 0.1321 grm. NH_4Cl = 3.20 per cent $(\text{NH}_4)_2\text{O}$.

In these analyses the first determination of the phosphoric oxide was made by double precipitation only, without subsequent treatment with ammonic sulphide ; but in the second this reagent was employed in the manner above described. The ratio of MoO_3 to P_2O_5 is almost precisely

24 : 1, and the analyses correspond closely with the formula—



which requires—

		Calc.	Mean.		
48MoO ₃	..	69.12	89.05	89.00	—
2P ₂ O ₅	..	284	3.66	3.75	3.70
5(NH ₄) ₂ O	..	260	3.35	3.39	3.39
17H ₂ O	..	306	3.94	3.86	3.81
		7762	100.00	100.00	3.92

Acid salts of similar type occur frequently in the class of phospho-molybdates, as in that of phospho-tungstates.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

December 5, 1881.

MR. ROBERT R. TATLOCK, President, in the Chair.

DR. WALLACE delivered his opening address, "*The Dissociation of Chemical Compounds*," illustrating his subject by numerous experiments :—

There are in chemistry two great and leading methods of research which have contributed equally to the advancement of our knowledge of the relations of the various elements to one another. One of them is called analysis, or decomposition, or dissociation—although the last-named term expresses analysis in a somewhat restricted sense ; the other is denominated synthesis, or combination. It is to the first of these methods of enquiry that I shall ask you to follow me in the remarks I shall address to you, and chiefly in the more limited sense implied in the term dissociation.

The word analysis in chemistry signifies a separation or splitting-up of a body into its component parts, such separated parts differing from each other and from the original body from which they were taken. This definition of analysis at once distinguishes chemistry from physics in the restricted application of the word. If we take a piece of marble, we can examine it either physically or chemically. In the first case we may estimate the exact size of the stone, its absolute weight in pounds, grms., or grains, as the case may be ; its weight as compared with that of an equal bulk of water, or specific gravity, as it is usually termed ; its relations to light, heat, and electricity ; its comparative hardness, and many other qualities. We may also, by mechanical means, break the lump in pieces and reduce it to powder ; but each minute fragment will still be a piece of marble, unchanged in all its properties. But how different is a chemical examination ! The application of an acid at once discloses the fact that the mineral contains a gas, and also a body which dissolves in the acid, forming a clear solution, from which it may afterwards be obtained by appropriate means. This is analysis or decomposition. The same mineral—which is simply one of the many forms of limestone—if exposed to a full red-heat in a furnace, is separated into its constituents ; lime remains behind, while carbonic anhydride—or, as it is commonly called, carbonic acid gas, escapes with the products of the combustion of the coal, although it can readily, by appropriate means, be collected and its properties examined. This is dissociation, or the separation of a compound body into its constituents, without the intervention of any other chemical agent. By various methods—some extremely

* *Journal für Praktische Chemie*, 44, 291.

† *Pharmaceut. Viert. jahresschrift*, 4, 549.

‡ *Jour. f. Prakt. Chemie*, 53, 342.

§ *Poggendorff's Annalen*, 109, 135.

|| *Jour. f. Prakt. Chemie*, 67, 470.

¶ *Loc. cit.*

** *Berichte der Deutsch. Chem. Gesellschaft*, 14, 1217.

simple, others highly complex—all substances, animal, vegetable, and mineral, within our reach, have been analysed or decomposed, or dissociated, until we have arrived at a number of bodies which we call elements—about 65 in number—which we have never yet been able to tear asunder into any simpler form of matter. Of these the greater number are metals, while a comparatively small proportion—about one-fifth of the whole—are either gaseous or possess properties of an opposite character to those of the metals. Among the latter, I may mention sulphur, phosphorus, iodine, bromine, and carbon. The distinction between the metals and non-metallic elements is not, however, so precise and absolute as might at first be supposed; phosphorus is closely allied to the metal arsenic, the metal chromium forms compounds like those of sulphur, and there are many other singular analogies. It was long accepted as an axiom in chemistry that the gas hydrogen was a metal, or acted the part of one; but it has, within the last few years, actually been condensed by intense pressure and extreme cold into a liquid, and even into a solid metal. Of this, however, I shall speak further on.

The forces by which bodies may be dissociated are various, but by far the most important is heat. In many cases compounds appear to have their constituents grouped together so loosely that the most insignificant application of force suffices to break them up. Thus the compounds usually called chloride and iodide of nitrogen (consisting of ammonia, the hydrogen of which is more or less completely replaced by chlorine or iodine) explode with violence on being touched with a feather, or by mere agitation of the air by which they are surrounded. The green hydrated oxide of copper holds its combined water so feebly that, on heating to the boiling-point, even below water, it is separated, and the black anhydrous oxide is produced. A weak solution of the crystallised chloride of cobalt, on being heated to boiling in a sealed tube one-third full, changes from the hydrated to the anhydrous condition, the separation of the water of hydration being made apparent to the eye by the liquid changing from pink to blue. Many ammoniacal salts become dissociated to a certain extent on their solutions being heated. The oxides of mercury are readily decomposed at a low red-heat (600° to 700° F.), and those of silver, gold, and platinum all give off their oxygen, leaving the metals in a pure condition, on exposure to a moderate heat. In other cases the decomposition is only partial, as when the black or binoxide of manganese is converted into the lower brown oxide, when chromic acid gives off half its oxygen, and becomes the green oxide of chromium, when iron pyrites gives off part of its sulphur; and many other cases of a similar nature.

Heat is only one of the many forms of force by which compound bodies are affected. Light has a distinct power of decomposing many chemical compounds. The salts of silver are particularly sensitive to light, and the art of photography depends entirely upon the effect of light on silver salts and other compound bodies. Vegetable colours are also readily changed by light, but by far the most important function played by light in decomposing compound bodies is displayed in the phenomena of plant life, in which carbonic anhydride, water, and ammonia are decomposed, and their elements re-arranged so as to give rise to an infinite multitude of new combinations, while oxygen gas is freely given off.

Electricity is a potent agent of dissociation, and is frequently used by the chemist, especially for the separation of metals from their solutions. One of the most familiar illustrations of the action of voltaic electricity upon chemical compounds is the decomposition of water, in which the two gases of which it is composed—oxygen and hydrogen—pass off from the two electrodes or terminals of the wires of the battery. A convenient form of the arrangement, as a lecture illustration, is that in which the gases, as they stream off, are collected in graduated tubes, so that the analysis is really quantitative. Although it is

wandering a little from our subject, it may be interesting to consider for a moment how it is that the gases appear at the two poles, which may be many inches apart. If we take a molecule of water, composed of one atom of oxygen and two atoms of hydrogen, and suppose this molecule to occupy a position in close contact with one of the poles, we can understand how one of the gases, say the oxygen, is evolved at that pole; but how does the hydrogen travel to the other pole? The answer to this is, that it does not travel at all, but unites with the oxygen of the nearest molecule of water in the direction of the current, which in turn gives up its hydrogen to the next molecule, and so on until the other pole is reached and the gas is disengaged. We have, as it were, a polarisation of the water, by virtue of which we may conceive that a series of molecules are distorted so as to have their oxygen pointing in one direction and their hydrogen in the other, the ultimate effect being as I have stated.

I may make another digression, but only for a moment, to ask your attention to the terms atom and molecule. With regard to atoms, we know the *relative* weight of these, and, in the case of gases, their *relative* dimensions, but of their actual weight or size we are, and must ever remain, in ignorance. It is true that in the case of certain elementary gases, mathematicians have made estimates of their probable size (for example, it has been calculated that the atom of hydrogen does not exceed one five-millionth of an inch in diameter); but even in such estimates as these we cannot tell whether we are dealing with ultimate atoms or molecules composed of an aggregation of atoms. It is certain that some gases, such as chlorine and iodine vapour, are composed of molecules or grouped atoms, since these can be dissociated by heat, the gases expanding in volume when the dissociation takes place. Neither can we tell whether elements, in combining together, unite atom to atom or molecule to molecule. In water, one of the simplest of chemical compounds, since it contains only two elements, we have oxygen and hydrogen in the proportion of one atom of the former to two atoms of the latter. But we cannot tell how these atoms are grouped. We can represent it with an atom of oxygen in the centre, with one of hydrogen on each side, or with one of oxygen above and a double atom of hydrogen below; but these are not at all likely to be correct. It is almost absolutely certain that the molecule of water has a geometric or solid figure, which could not be made up of less than six atoms, and probably is much more complex. A system of representations of compound bodies by diagrams, called *graphic formulae*, have for some years been employed by some of our leading chemists, and are said to be useful in teaching the science. To my mind they form a stumbling-block rather than an assistance to the student, who is constantly confronted with representations of arrangements which cannot by any possibility exist in nature.

Other examples of the dissociation of compounds by electrical agency might be mentioned. Hydrochloric acid is easily decomposed, hydrogen gas being given off at one pole and chlorine at the other; but the chlorine, being soluble in the liquid hydrochloric acid to some extent, is not immediately evolved in the gaseous state. Its presence may, however, be evidenced by its bleaching action upon vegetable dyes—indigo, for example, being at once decolourised by the electrolysed hydrochloric acid. In like manner hydriodic acid is decomposed by the electrical current—or, what amounts to the same thing, a solution of potassium iodide acidulated with hydrochloric acid. On passing the current, iodine is immediately set free, and may be distinguishing by forming a blue compound with starch, while hydrogen is disengaged at the opposite pole.

In the practical arts the deposition of metals has now become an industry of enormous dimensions. The manufacture of electro-plate alone engages thousands of operatives in Birmingham, Sheffield, and other towns; and, among other branches of the art, I may mention electro-gilding, and the deposition of copper, brass, and nickel—

the last a comparatively new industry, which is rapidly assuming large proportions. In these cases the battery has been replaced by the steam-engine, the mechanical force of which is converted into the electric current by the magneto-electric machine, where permanent magnets are employed, or the dynamo machine, in which electro-magnets are used.

The fact of metals being constantly set free at one pole of a battery, while what we call, for want of a better name, non-metallic elements, appeared at the other, led many years ago to the introduction of the term electro-positive elements for the metals, including hydrogen, and electro-negative for the opposite group, including chlorine, iodine, bromine, fluorine, oxygen, sulphur, and so on. These terms, however useful in their time, are scarcely, if at all, used by chemists at the present day.

To return to the action of heat in its action upon chemical compounds, I have now to carry you a little further. We have seen that many compounds are readily decomposed; but there are others which require the highest temperature at our command for their decomposition. Until very recently water was supposed to be incapable of being separated into its elements by heat alone. By an ingenious contrivance Sir William Grove succeeded in effecting the re-solution of this compound, and in this way:—In a flask water was made to boil, and in a tube which received the steam a succession of electric sparks were passed from a Ruhmkorff coil, and the steam further on was condensed, while the gases formed by the dissociation of the watery vapour by the intense heat of the electric spark were carried forward by an aspirator or Sprengel pump into an appropriate receiver. In this case the gases, once separated, were pushed on by the large volume of steam, otherwise they would have re-combined. In many experiments in the laboratory we use the electric spark to explode mixtures of oxygen and hydrogen, and it is, in fact, the only means we can employ if we have to measure the amount of condensation which follows the explosion. We can readily produce, in furnaces, degrees of temperature amply sufficient for the decomposition of water (2000° C., or 3632° F.), and there is not the slightest doubt that such decomposition is constantly taking place; but the gases are immediately re-combined. But there are complications in this case—the carbon of the fuel reacts upon a portion of the watery vapour, and carbonic oxide and carburetted hydrogen result, which, on the top of the fuel, burn to carbonic acid and water—exactly the same result following as if there had been no decomposition of the water. As the heat absorbed or rendered latent in the act of decomposition is exactly equivalent to that which results from the subsequent combustion, it follows that the introduction of steam into a furnace does not increase the gross amount of heat due to the combustion of the fuel, but it frequently has the useful effect of carrying forward in the furnace the zone of highest temperature, and so serves a useful purpose.

Perhaps the most important example of dissociation presented to us within a comparatively recent period is that of carbonic acid gas, which was effected by Deville in 1868. This eminent chemist showed that at an extremely high temperature carbonic acid (CO_2) is dissociated into carbonic oxide (CO) and oxygen. Further than this, CO is decomposed, two atoms of it giving one atom of carbon and one atom of carbonic anhydride, the ultimate result being the re-solution of the original compound into carbon and oxygen. A peculiar arrangement is required for the performance of this process—a ring of metal kept cold by a current of water being close to the gases, heated to an intense degree by the electric spark, and the carbon is deposited upon the cold metal. I consider this a most important discovery, not merely as a scientific fact, but as an explanation of phenomena which could not otherwise be accounted for. In an ordinary furnace, such as those employed in the Siemens-Martin process, and others in which an intense heat is obtained, there is evidently a limit beyond which no further increase of temperature can

be obtained—for this reason, that carbon and oxygen refuse to combine at a very exalted temperature, the exact degree of which we cannot exactly define, but which has been estimated at about 5000° F.

In the compounds of carbon and hydrogen we have a more familiar illustration of dissociation. If we pass one of the gaseous hydrocarbons, containing a large proportion of carbon—such, for example, as ethene (C_2H_4), popularly known as olefiant gas, or the vapour of a liquid hydrocarbon such as benzene, or of a solid such as naphthalene through a glass tube heated to bright redness, a deposit of carbon takes place, and the gas or vapour that passes on contains a greater or less proportion of methane or marsh-gas (CH_4). This is a well known fact in some manufacturing processes. In gas making, the retorts, especially at the back, become coated, often to the extent of several inches in thickness, with a solid deposit of carbon, which results from the decomposition of the gaseous liquid and solid hydrocarbons evolved from the coal by the action of heat. We may go further than this, and say that the production of illuminating gas from coal is itself an illustration of dissociation, for carbon is left behind, mixed with the mineral matter of the coal, forming coke, while the hydrogen and oxygen combine with a portion of the carbon, forming gaseous and liquid hydrocarbons and carbonic oxide, besides some other compounds containing sulphur and nitrogen. Again, if we distil coal-tar or crude paraffin oil we obtain in the retort or still a portion of solid carbon and a distillate of oils, containing less carbon than the original liquid. If we bring paraffin oil drop by drop, or in a thin stream, into a gas-retort heated to bright redness, a thin and poor gas is obtained, and much solid carbon is set free, but at a low red-heat a rich gas is produced, with no carbonaceous deposit. But to pursue this subject further, marsh-gas, by exposure to a still higher temperature, either by the electric spark or in a porcelain tube placed in a furnace, yields hydrogen and a richer hydrocarbon, acetylene (C_2H_2), which in turn is decomposed into carbon, hydrogen, and some marsh-gas, the ultimate result being that all hydrocarbons are resolvable by heat alone into carbon and hydrogen.

I could dwell on this subject much further, but it is unnecessary. Let us now see to what conclusion these experimental results lead. It is simply this—that by the action of heat all compound bodies are resolvable into their elementary constituents, and that if we had a world, or planet, or sun, the temperature of which was sufficiently high, we should there have simply a collection of elementary bodies. That is a conclusion to which we are forced by experiment and analogy. Some of us may not be able to realise the existence of such conditions as I have stated as being necessary, but we must acknowledge that, if such conditions did exist, the result would follow, just as we accede to the statement that if water is exposed to a sufficiently low temperature it will freeze.

(To be continued.)

CORRESPONDENCE.

CAUSTIC POTASH.

To the Editor of the Chemical News.

SIR,—In the midst of a general depression of the alkali trade, there is a branch which has, I think, been somewhat overlooked by our usually enterprising manufacturers. I mean the production of a "Commercial Caustic Potash" suitable for soft soap makers. As is well known, the usual method of obtaining caustic potash lye is by causticising American potashes (solution) at a high specific gravity, drawing off the supernatant clear liquor for saponifying the oil, and washing the residual lime several times, and using this for making up a fresh quantity of lye instead

of water. This process involves a large outlay of capital and occupies a very considerable space, and, moreover, it is a very unscientific or "rule-of-thumb" process, giving a product of very uncertain composition. What is required is a caustic potash containing about 70 per cent hydrate of potash and reasonably free from soda salts and carbonic acid. If such an article could be produced at a moderate price, it would be a great boon to soap makers, and I am certain it would command a large sale. As far as I can ascertain, there is only one works in England producing caustic potash, and their product is certainly very pure, but the price is proportionately high; doubtless it is very costly to manufacture this high-strengthed article. There may be obstacles in connection with the manufacture of this article, but I have no doubt the skill and perseverance of our chemists would overcome these difficulties.—I am, &c.,

R. J. T.

St. Helens, January 17, 1882.

THE NEW ALKALOID—HOMO-QUININE.

To the Editor of the Chemical News.

SIR,—Mr. David Howard, by his letter in the CHEMICAL NEWS, vol. xlv., p. 21, seems to imply that the note by Mr. Barret and myself (vol. xlv., p. 6) casts some doubt on the existence of homo-quinine. I beg to point out, therefore, that we did not give expression to any such doubt. Mr. Howard is a high authority on such matters, and we had no desire to call in question his results. We merely directed attention to a compound that may be easily formed in working cuprea barks, and, from its property of crystallising from ether, might be mistaken for the new alkaloid.—I am, &c.,

C. H. WOOD.

Mildmay Chambers, 82, Bishopsgate St., E.C.,
January 17, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 26, December 26, 1881.

Mode of Action of Soluble Ferments.—A. Wurtz.—The author's experiments show that the two soluble ferments, pepsine and papaine, whilst becoming fixed in the insoluble state upon certain albumenoid bodies, modify these latter, so that they can become hydrated at a temperature of 40° by the action of pure water, forming true peptones.

Contractions and Expansions Produced by Electric Tensions in Hemihedral Crystals with Inclined Surfaces.—J. and P. Curie.—When the two extremities of the axis of a hemihedral crystal are charged with opposite electricities it undergoes along that axis, either contraction or expansion, according to the direction in which the electric tension has been applied.

Influence of Heat and of the Proportions of Glycerin on the Decomposition of Oxalic Acid.—M. Lorin.—The etherification of formic and oxalic acids in this kind of experiments is a secondary accident.

Decomposition of Certain Metallic Acetates in Presence of Water: Production of Crystalline Mineral Species.—J. Riban.—The acetates are not decomposed in the same manner as the formiates (*Comptes Rendus*, xciii., pp. 1023 and 1082), evolving carbonic acid and marsh-gas, but are resolved into acid and metallic oxides, sometimes well crystallised, and some gases re-

sulting from the ulterior action of the regenerated compounds, but no hydrocarbons.

Essence of Angelica.—M. Nauden.—The chief constituent of this essence is an isomer of the oil of turpentine, $C_{10}H_{16}$. It is a colourless liquid, boiling at 175°, and having a smell of hops. Its density at 0° = 0.833.

Method of Purifying Arsenical Copper.—J. Garnier.—The author operates on a basic hearth of lime and tar according to the process of Riley and Gilchrist, and at each operation he uses a false hearth of lime-stone mixed with peroxide of manganese. During the fusion of the ingots this false hearth is heated and gives off carbonic acid and a part of its oxygen. These gases traverse the mass of half-melted copper. When the bath is sufficiently liquid the lime and the manganese oxide thus formed rise through the copper and dissolve the arsenic acid, which passes into the slag. To expel the last traces the copper is allowed to become pasty in a current of air, and is then re-melted with the addition of basic fluxes till entirely purified.

Bulletin de la Société Chimique de Paris.
Tome 36, Nos. 6 and 7.

Russian Chemical Society.—Meeting of Feb. 5/17, 1881.—The President communicated the following researches conducted in the laboratory of the University of Moscow:—On dipropyl-oxalic acid, by M. Rafalsky; on the fumaric and terephthalic acids, by M. Lapine; on the petroleum of the Caucasus, by MM. Markownikoff and Oglobline.

M. Petouhoff communicated a paper on the reduction of carbonic anhydride by sulphur.

M. Menshutkine explained a method of determining the chemical value of the components of the alcohols. He also presented to the Society, on behalf of M. Tommasi, a dissocioscope,—an instrument for showing the dissociation of ammoniacal salts.

M. Lavroff announced that he had not succeeded in preparing carbon oxychloride by M. Paterno's method.

M. Chichkoff called the attention of the Society to certain regularities presented by the atomic weights of the elements. On occasion of this communication—

M. Boutlerow announced that he had undertaken researches on this subject, which he proposed to continue. He remarked that on the one hand the researches of M. Stas have clearly established that the majority of the atomic weights could not be presented by whole numbers. On the other hand, the majority of the atomic weights differ from whole numbers so slightly that this fact can scarcely be regarded as accidental. May it not be admitted that under certain conditions the atomic weights may be really expressed by whole numbers with reference to $H=1$? That is to say can we not admit that the atomic weights present values capable under given conditions of varying within certain limits. Such a hypothesis would not be absolutely inadmissible, for the atomic quantity of an element is in reality merely the vehicle of a determinate quantity of chemical energy; but the value of such a quantity must be determined not merely by the mass, but also by the velocity. This latter being changeable, the mass may likewise be modified, so long as the chemical value remains invariable. However this may be the absolute invariability of the atomic weights is an *a priori* hypothesis which has not yet been based upon exact experiments. M. Stas, when verifying the constancy of the composition of ammonium chloride prepared by different processes, evidently entertained ideas of the same order. It is therefore not useless to check experimentally the invariability of the atomic weights, and on this account the author has undertaken the determination of the weights of white phosphorus and red phosphorus.

M. Wagner communicated a general method of preparing the secondary alcohols.

M. Butlerow announced that he had repeated the ex-

periment of Mr. Carnelley by heating ice under a feeble pressure, but without succeeding in raising its temperature.

M. Louguinine made a communication on the combustion-heat of the tertiary glycol, pinacone.

Moniteur Scientifique, Queneville.
November, 1881.

Studies on the Alkaloids.—M. de Bechi.—A continuation from the October number.

Influence of Coal-Dust in Explosions in Coal Mines.—Prof. Abel.—A translation from the English.

Exhibition of 1878.—C. Lauth.—The author describes the artificial production of vanilline, of salicylic acid, the production of trimethylamine and methyl chloride from the dregs of the distillation of beetroot treacle, and the manufacture of the alkaloids.

The Action of Pilocarpine upon the Colour of the Human Hair.—Dr. Prentiss.—Pilocarpine, the alkaloid of jaborandi (*Pilocarpus pennatifolius*), used in medicine as a sudorific, has been found when administered by hypodermic injection to alter the colour of the hair from a light blonde to an almost pure black.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 14, 1881.

The Abbé Moigno complains, in an able article, of the treatment which M. Tommasi has recently experienced in the suppression of his researches on the decomposition of water and their subsequent appropriation.

Electric Machines.—H. Valette.—A continuation from No. 11, containing several illustrations.

Journal für Praktische Chemie.
Nos. 19 and 20, 1881.

Opianic Acid.—O. Prinz.—By the action of nitrous acid upon opianic acid it yields a small quantity of nitro-hemipinic acid. Dilute nitric acid gradually converts opianic acid into hemipinic acid. Monohydrated nitric acid gives rise to nitro-pianic acid, $C_{16}H_9NO_7$, nitro-hemipinic acid, and an insoluble unnamed body. By the reduction of nitro-pianic acid with stannous chloride, he obtained azo-pianic acid. On treatment with potassium chlorate and hydrochloric acid there is formed monochloro-pianic acid. Bromine likewise yields with opianic acid a substitution-product. The author likewise examines the methyl-noro-pianic acid of Matthiessen and Foster, formed by the prolonged treatment of opianic acid at 100°. He also examines the action of phosphorus pentachloride upon the hemipinic and the opianic acids, and the reduction of opianic acid chloride.

My Part in the Development of Theoretical Chemistry (Fourth and last Part).—H. Kolbe.—A long and severe, but exceedingly able, critique on Kekulé and his school.

Trichlor-quinonimide and its Transformations.—R. Schmitt and M. Andresen.—The authors describe trichlor-para-amido-phenol, trichlor-quinon-chlorimide and its behaviour with aromatic primary amines, with dimethyl-aniline; the behaviour of trichlor-quinon-dimethylanilinen-imide with reducing agents, trichlor-dimethylen-amido-phenol, and trichlor-dimethylen-amido-phenol-sulphonic acid.

Apparatus for Receiving and Measuring Gases, and especially for the Direct Determination of Nitrogen.—R. Schmitt.—The construction of the apparatus cannot be made intelligible without the accompanying illustration.

Transformation of Morphine into Codeine and Analogous Compounds.—E. Grimaux.—From *Comptes Rendus*, 92, p. 1140, and 93, p. 67.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 3.

Remarks on the Analysis of Water.—A. Wagner.—The author considers the process of Frankland and Armstrong quite excluded in case of the water of town-wells and of streams which have received sewage or manufacturing refuse. The methods depending on the reduction of silver nitrate or potassium permanganate are equally to be rejected. For the qualitative detection of nitrates in well-waters, the author recommends the brucine process, conducted as follows: He pours 1 c.c. of the water in question into a small porcelain capsule holding about 10 c.c.; he then adds a granule of brucine, and, by means of a platinum spoon holding this quantity, $\frac{1}{2}$ c.c. of concentrated sulphuric acid. With small traces of nitrates there appears immediately, where the brucine lies, a transitory red reflection. In this manner 1 part of a nitrate may be detected in 500,000 parts of water. The diphenylamine reaction is equally sensitive. It is applied in the same manner as the brucine test, but a double quantity of sulphuric acid is used. If the nitrate is present in large proportions, an intense blue colour immediately appears; if the quantity is small, the blueness is seen after a little time, and passes into a yellow. This reaction is even less interfered with by the presence of organic matter than that with brucine. As regards the quantitative determination of nitrates, the author rejects the process of Schlösing, except in waters rich in nitrates and organic matter. He condemns the methods based on the oxidation of indigo. Where time is an object he proposes the following method: Pour into a flask fitted with a stopper a known volume of distilled water. If the water under examination—and which has been found to give a perceptible reaction with brucine—is added from a burette, constantly agitating, a point is reached at which a c.c. of the mixture, if taken out and tested, gives a perceptible redness. In this case 1 litre of the mixture of known quantities of distilled water and of spring-water must contain between 2 and 1.66 milligrams of nitrate and of course equivalent proportions of nitric acid.

Limits of Sensitiveness of some Reactions for Iron and Copper.—A. Wagner.—For iron, the author finds the limit of visible reaction with potassium ferrocyanide 1 part in 500,000; with potassium sulphocyanide, 1 part in 1,600,000; and with tannic acid, 1 part in 350,000, the limit in this latter case being indistinct. For copper, with ferrocyanide, the limit is 1 part in 200,000 of water; with ammonia, 1 part in 25,000; and with potassium xanthogenate, 1 part in 900,000 of water. For silver, with potassium xanthogenate the limit is 1 part in 40,000 of water. For mixtures of ferric and cupric salts, with potassium ferrocyanide the blue reaction was faintly perceptible in a mixture of $3\frac{1}{2}$ vols. cupric and 1 vol. ferric solution, each containing 1 part metal in 100,000 water. With ammonia the blue reaction was first perceptible in a mixture of 1 vol. cupric and $\frac{1}{2}$ vol. ferric solutions, each containing 1 part metal in 10,000 water. If the iron is in larger proportion there appears merely a yellow colouration. On these limits of reaction the author founds an approximate method for the determination of iron and copper, the procedure being in principle the same as that above described for the determination of nitrates.

The Determination of Potassium in Potassium Sulphate.—Dr. West.—The author remarks that the ordinary method of removing the sulphuric acid by means of barium chloride and converting the excess of the latter into barium carbonate by evaporation and ignition with oxalic acid, is open to a double objection. Barium sulphate retains much potassium chloride, even in an acid solution, and during the ignition a further quantity of barium chloride is lost by volatilisation. At Stassfurt the following method is in use: 10 grms. of the salt in question are placed in a 500 c.c. flask, with 350 to 400 c.c. of water and 25 c.c. of hydrochloric acid at 25 per cent, and solution of barium chloride (almost saturated, and con-

taining 50 c.c. aqueous hydrochloric acid per litre) is gradually added, boiling up each time, till the sulphuric acid is exactly thrown down, a point easily reached with practice. A very small excess of sulphuric acid has no effect upon the result, whilst an excess of barium chloride increases the result. Or the sulphuric acid in the salt may be determined volumetrically in a separate portion with barium chloride and potassium chromate, and the quantity of barium chloride thus found is added to the potassium salt in an acid solution. In evaporating, care must be taken that the free hydrochloric acid is entirely expelled, which is not easy in presence of much magnesia, otherwise an error may arise of 0.5 per cent. The correction for the potassium chloride retained by the barium sulphate is as follows: In 10 grms. potassium sulphate there are 4.59 sulphuric anhydride = 13.79 grms. barium sulphate, which occupy the space of 3 c.c. Each c.c. of the precipitate contains as much potassium as 6 c.c. of the solution.

Testing Petroleum.—C. Engler and R. Haass.—The three physical properties, refraction, specific gravity, and boiling-point, afford neither singly nor taken together an indication of the safety of a sample of petroleum.

The Detection of Magenta, Orchil, and Cudbear in Wines.—Dr. B. Haas.—According to Romi 100 c.c. of wine are mixed with an excess of basic lead acetate, heated, and filtered. To the filtrate a little more basic lead acetate is added in order to ascertain if the precipitation was complete, and the filtrate is then shaken up with amyl alcohol. The two colours, orchil and magenta, are then distinguished as follows: The red stratum of amyl alcohol is carefully poured into a dry test-tube and mixed with water. It is decolourised if the red colour was due to magenta, but not if it is owing to orchil or cudbear. The baryta method of Pasteur, Balard, and Wurtz, and the magnesia test, are useless if it is required to distinguish magenta from orchil and cudbear.

Determination of Phosphoric Acid in the Ashes of Grain.—E. v. Raumer.—In order to avoid the conversion of the phosphoric acid into pyro-phosphoric acid during carbonisation, the author adds baryta-water and dries, when carbonisation takes place rapidly at a moderate temperature.

An Improvement in Reading off Hydrometric Degrees, especially for Determining the Specific Gravity of the Fatty Matter of Butter.—A. Mayer.—This paper requires the accompanying illustration.

The Reactions and the Detection of Glycerin.—E. Donath and J. Mayrhofer.—To detect glycerin in the possible presence of sugar, the liquid in question is mixed with powdered slaked lime and an equal bulk of fine quartz sand, and evaporated to a paste on the water-bath. When cold the residue forms a hard mass, which is pulverised and extracted with 80 to 100 c.c. of a mixture of equal volumes of absolute alcohol and ether in a small stoppered flask. On allowing the extract to evaporate, the glycerin is obtained free from sugar. If two drops of it are put in a dry test-tube with two drops of phenol (previously liquefied), and the same quantity of sulphuric acid, and heated very cautiously over the flame, but so as to reach 120°, the formation of a solid brownish yellow mass is perceived. When cold a little water is added, and a few drops of ammonia, when the brownish yellow solid dissolves with a splendid carmine red colour.

MISCELLANEOUS.

Animal Chemistry in the Daily Press.—An evening paper informs the public that "we need even siliceous particles to form our bones." Considering that the silica found in recent bones is about 0.01 per cent of the total mineral matter, the "need" does not seem very pressing.

Recognition of the Ptomaines.—Brouardel and Boutmy assert that the ptomaines quickly reduce potassium ferricyanide, which the vegetable bases are unable to effect. P. Spica shows experimentally that this distinction does not hold good, and that the ferricyanide is reduced also by the vegetable bases.—*Gazzetta Chimica*.

NOTES AND QUERIES.

*Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Glycerin.—Would any kind reader give me a good confirmatory test or two for glycerin. I have looked in various books but have been unsuccessful in meeting with one.—W. RAY.

MEETINGS FOR THE WEEK.

- MONDAY, 23rd.**—London Institution, 5. Medical, 8.30.
TUESDAY, 24th.—Institute of Civil Engineers, 8. Royal Institution, 8. "The Mechanism of the Senses," Prof. J. G. M'Kendrick. Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 25th.—Society of Arts, 8. "The Causes and Remedies of Bad Trade," by Walter R. Browne, M.A. Geological, 8. King's College Science Society, 8. "The Action of Light upon Certain Substances, and its Application to Photography," by J. M. Thomson F.R.S.E., F.C.S. (Admission by private card.)
THURSDAY, 26th.—Royal, 4.30. Royal Institution, 3. "Corals," Mr. H. N. Moseley. Philosophical Club, 6.30. Society of Arts, 8. "Recent Researches into the Theory of the Living Contagium, and their Application to the Prevention of Certain Diseases in Animals," by T. L. W. Thudichum, M.D. London Institution, 7.
FRIDAY, 27th.—Royal Institution, 8. "The Museum and Libraries of Alexandria," by Mr. R. S. Poole, 9. Quekett Microscopical Club, 8.
SATURDAY, 28th.—Royal Institution, 3. "Ludwig van Beethoven," by Prof. Pauer. Physical, 3. "On the Fluid Density of Metals," by Prof. W. Chandler Roberts and T. Wrightson. "On Apparatus for Calculating Efficiency," by C. Vernon Boys. "On a New Electric Meter," by C. Vernon Boys.

TO CHEMICAL MANUFACTURERS &c.

DARWEN CORPORATION GAS WORKS.

The Gas Committee of the above Corporation are prepared to receive TENDERS for the Surplus Tar and Ammoniacal Liquor produced at these Works for one, three, or five years, from March next. Coals carbonised, about 9000 tons annually. Further particulars and Forms of Tender may be had on application to the undersigned.

Sealed Tenders, endorsed "Tender for Tar or Ammonia Liquor," to be sent to C. COSTER, Esq., Town Clerk, Darwen, on or before February 14th next. By Order—

THOS. DUXBURY,
Manager Gas Works, Darwen.

ROYAL POLYTECHNIC, open for four weeks only.—The Institution having been sold, it will positively and finally close on the 21st of January. Until then, a most varied and attractive programme will be presented daily, including new Musical, Optical, Magical, and Popular Scientific Entertainments, as well as a *réchauffé* of very many of those that have delighted its audiences during the last 20 years. The Institution remains open from 12 till 10, with a continuous series of Entertainments, and without any extra charges. Distributions of Gifts from the Christmas Tree to every juvenile visitor, on Wednesday afternoons. Admission 1s.; children under ten, 6d.—Manager, Mr. James Howell.

Chemical Balance for Sale.—One of Oertling's 14 guinea; scarcely ever been used, and as good as new.—No reasonable offer refused.—Address, W. J., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

THE CHEMICAL NEWS

VOL. XLV. No. 1157.
28 JAN 28 1882

MANOMETRIC OBSERVATIONS IN
THE ELECTRIC ARC.*

By Professor DEWAR, F.R.S.

THE experiments recorded in my former paper, entitled "Studies on the Electric Arc,"† together with the numerous observations made conjointly with Professor Liveing on the spectrum of the arc discharge between carbon electrodes in different gases, led me to ascertain if the interior of the gaseous envelope of the ordinary arc showed any peculiarities of pressure. Pressure might be caused by the motion of the gas particles, the transit of material from pole to pole, electric action, or indirectly by chemical combinations taking place in the arc. As any effect due to the above causes must necessarily be very small, a delicate manometer capable of measuring easily the one-hundredth of a millimetre of water pressure had to be employed. The records of such an instrument in the present series of experiments, are complicated by the indirect action of the hot currents of air passing the poles, and the irregularities in the steadiness of the arc which undoubtedly cause marked variations of pressure; yet by multiplying and varying the conditions of the experiments, it is possible to eliminate these secondary effects and secure reliable results. The apparatus consists of two hollow carbons, like what I have formerly employed in the separation of cyanogen from the arc.‡ They must be free from all porosity before they can be used in the experiments to be detailed, and the drilled hole should not be less than three millims. in diameter. In order to fill up minute apertures in the carbons, and render them non-porous, they are placed in a porcelain tube and heated to a white heat in a current of coal-gas saturated with vapour of benzole. This treatment causes the deposition of a layer of dense metallic carbon over the surface of the tubes, which renders them capable of withstanding a considerable interior pressure of air or other gas without exhibiting leakage. The hollow poles are connected by means of tubing with two manometers. The tubes leading from the hollow poles have been made of metal or thick india-rubber, and to prevent heating of the tubes and manometer by radiation from the arc, they have been carefully guarded by hollow tin screens through which a current of water flowed continuously. The lengths of the tube between the manometers and poles have been varied, and in some cases the tube made into a spiral form has been immersed in water so as to guard against unequal heating. In the experiments water, ether, and alcohol have been used in the manometers, but the largest number of the experiments have been made with ether. This fluid is most convenient from its mobility, and the only precautions to be taken are to use plain cork stoppers instead of india-rubber, and to have a considerable length of tube between the manometers and the arc. By careful levelling and the use of ether as the fluid 1 millim. of motion of the fluid in the horizontal tube may be made to correspond to about the 250th of a millim. of water pressure. In the present investigation, as the absolute value of the pressure is not so important as the general variation, I have not thought it advisable to give other than relative records taken with the same instrument at different times; it is quite possible, however, to get absolute values of very small pressures by means of

this instrument, and I have satisfied myself of its accuracy by measuring a series of pressures of soap bubbles of different sizes, which confirm the previous observations of Plateau that the internal pressure varies inversely as the diameter of the bubble.

When the arc passes between two pointed carbon poles it assumes two very different forms; in one case the envelope of the intensely heated gaseous materials is well defined, almost spherical in appearance, surrounding the whole of the end of the positive pole, but touching the negative only at a single point without showing that close adhesion to the pole which is so characteristic of the layer of gas at the positive. At other times the arc is very unsteady, noisy with apparent blasts of green flame-looking ejections, which generally arise from the positive pole. These blasts are invariably associated with a great increase of intensity in the hydrocarbon and cyanogen spectrum. While the arc is in this unstable condition manometric observations are impossible, as the small area of the carbon tube is rarely completely covered by the arc, so that the manometers often record neither positive nor negative pressures during the discharge. The effect of the hot poles on the registration of the manometers is to produce a small negative pressure when the arc has stopped, due to the passage of currents of hot air. Many experiments were made to ascertain if a local heating of the carbon tube caused any permanent pressure. This was carefully tested by taking the arc at right angles to a carbon tube placed in a block of magnesia so as to raise the middle of the tube to the highest possible temperature. Under these conditions the manometer connected with the hollow carbon remained perfectly steady; whether the tube was made the positive or negative pole of the battery. This experiment also showed that repulsion of the inclosed gas in the tubes through an electric charge, had no effect on the manometer. During the maintenance of the *steady arc*, the manometer connected with the positive pole exhibits a *fixed increase of pressure*, corresponding to a motion of the fluid in the horizontal tube of the manometers employed, of from 50 to 150 millims., which is equivalent to from 1 to 2 millims. of vertical water pressure in different experiments and under varied conditions. The manometer connected with a negative pole shows no increase of pressure, but rather on the average a diminution.

When the arc begins to emit a hissing sound, the pressure on the positive pole instantly diminishes, and when blasts are ejected from the positive in the direction of the negative, the negative manometer which had stood at zero before showed a marked increase of pressure. If a commutator is placed in a circuit, so as to quickly reverse the direction of the original current, the arc is not broken, but the manometers immediately record a reverse action. In order to equalise the temperature of the poles to some extent, the arc was taken in the middle of a block of magnesia, but the same results were observed; the pressure is generally smaller in the hot crucible than it is in air. When the crucible gets highly heated and filled with metallic vapours, the arc will pass a distance of more than an inch, and in this condition the shorter the arc the greater the pressure. It was found advisable in these experiments to use a negative pole which had a sharp conical termination, otherwise the form of the arc in the block of magnesia was very irregular, owing to the high conductivity of the hot walls of the crucible. When the poles are brought into contact in the magnesia crucible, the pressure at the positive instantly falls.

Whether air, carbonic oxide, or nitrogen filled the manometer and carbon tubes the results were invariably the same. The chief experiments have all been made with the Siemens machine, but a 70 cell Grove's battery produced the same results. The use of the horizontal arc is a matter of convenience, as in this condition the manometers are least affected by air currents, but the same general action may be observed by the use of vertical poles. A thin carbon spatula placed in front of the end of the

* Abstract of a Paper read before the Royal Society, January 19th, 1882.

† *Proc. Roy. Soc.*, 1880, page 85.

‡ *Proc. Roy. Soc.*, 1879, page 185.

positive pole at once lowered the positive pressure of the manometer. This experiment does not prove much, as the carbon diaphragm causes a noisy and unsteady arc until a minute hole is pierced by the current. It is probable the diminution of pressure may be due to the instability of the arc. In the same way the action of the magnet on the arc causes an instant reduction of the positive pressure by withdrawing the arc from completely covering the end of the carbon tube, so that this action must be regarded as an indirect one. A small carbon tube connected with a manometer was inserted into the arc, passing between two solid carbons, so as to take a section at right angles to the passage of the current. In this condition the arc is apt to be irregular in shape, and to pass rather between three poles than two, but the average records point to an increase of pressure in this position also. When the negative carbon tube is about 1 millim. in diameter, and the point sharp and the tube short, so as to diminish any air friction, the negative pole manometer seems also to give a positive pressure.

It appears from the above experiments that the interior of the gaseous envelope of the electric arc always shows a fixed permanent pressure, amounting to about a millimetre of water above that of the surrounding atmosphere. This looks as if the well-defined boundary of the heated gases acted as if it had a small surface tension. This pressure may be due to various causes; motion of the gas particles under the conditions; transit of material from pole to pole; or a succession of disruptive discharges, and a more elaborate investigation will have to be made before the origin of the excess of pressure is clearly defined.

ON A METHOD FOR ESTIMATION OF ORGANIC NITROGEN IN LIQUIDS AND SOLIDS.

By WILLIAM BETTEL.

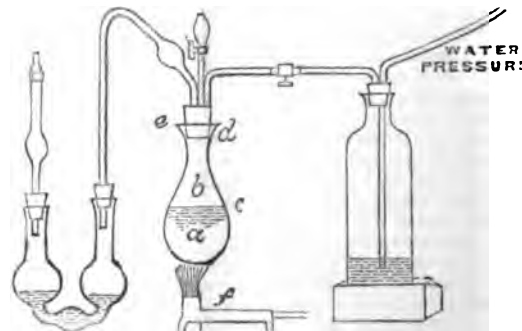
PRELIMINARY NOTICE.

THE difficulty and expense of Dr. Frankland's process for organic nitrogen determination led me to devise a method less expensive than the soda lime process, and unailing in accuracy, easily worked, and estimating either large or small quantities of nitrogen as ammonia by titration or Nesslerising. I found that by removing nitrates by the copper zinc couple, I could easily estimate the total organic nitrogen in solution by evaporation of water (after removing ammonia, free, and from decomposition of nitrates), with pure solution of caustic soda in a copper flask of peculiar shape, finally evaporating to dryness and igniting, adding water, and re-distilling. I could, by suitably collecting the ammonia, obtain results which agreed with the previous history of the water as regards contamination. Having perfected the method I found that urine, abnormal and healthy, and organic fluids in general, including milk, beer worts, extracts, &c., containing no nitrates, could be thus examined far quicker than by any other known process for total nitrogen estimation, whilst for simplicity and accuracy it resembled an ordinary ammonia estimation by distillation. Where, upon ignition, cyanides are formed in the flask, sufficient permanganate is added to oxidise to cyanates. These by ebullition are converted into ammonia, and so estimated. I have obtained theoretically accurate percentages of ammonia from ferrocyanide of potassium, urea, uric acid, hippuric acid, albumen, &c., and slightly higher results for other substances, solid and liquid, than yielded by the soda lime process.

At present I will content myself with giving a sketch of the copper flask I use for general work, merely mentioning that the apparatus is in use in two large breweries in the country for daily examination of yeast, malts, worts, and beer. The capacity of the flask is about 300 c.c., and is

made in three pieces. *a*, beaten out of stout sheet copper, and brazed to *b*, made of drawn tube, at junction *c*. The copper cup, *d*, is intended to hold a little water to cool cork inserted in neck, *e*, when the lower part is heated to redness. The cork is triply perforated to admit of stoppered separating funnel tube, tube from hydrogen gas-holder (conveniently made out of two "Winchester quarts"), and the third to either condenser or bulb arrangement with normal sulphuric acid, with methyl-orange as indicator.

The following drawing shows the apparatus as arranged for titration of NH_3 .



f. Fletcher's Argand.

I have had a number of the copper flasks made specially, and shall be happy to supply them with the necessary fittings to any chemist, with the mode of procedure.

29, Castlemain Road, Camberwell,
London, S.E.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 19, 1882.

Prof. H. E. Roscoe, President, in the Chair.

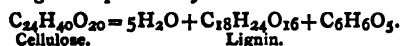
THE following certificates were read for the first time:—H. J. Alford, A. Blaikie, W. E. Bush, J. J. Beringer, G. W. Davies, W. Hamilton, T. Isherwood, H. H. Philipps, H. Porter, C. H. Riddale, V. P. Sells, L. T. Thorne, S. Young. During the evening a ballot was held, Drs. Wright and Japp being appointed scrutineers. The following gentlemen were declared duly elected Fellows of the Society:—F. Barkas, E. D. Chester, J. Gray, H. E. J. Irons, J. P. Laws, F. H. Lescher, D. O. Masson, H. F. Moore, T. Perry, J. R. Parker.

The PRESIDENT then called on Mr. Cross to read a paper on "The Chemistry of Bast Fibres," by C. F. Cross and E. J. BEVAN. In a previous paper (see CHEMICAL NEWS, vol. xlii., p. 77, and Chem. Soc. Journ., xxxviii., p. 666), the authors established the following points:—The chemical similarity between the non-cellulose constituents of mono-cotyledonous and di-cotyledonous fibres; the resolution of the jute fibre by chlorine into cellulose (using this word in a general sense) and the chloro-derivative of an aromatic body, $n(\text{C}_{10}\text{H}_8\text{Cl}_4\text{O}_6)$, all bast fibres examined (flax, hemp, manilla, esparto, &c.), yielded a similar body. The reactions of this substance suggested the hypothesis that it was a complicated derivative of tetra-chlor-quinone. Jute fibre was resolved by boiling dilute hydrochloric or sulphuric acid into a soluble carbohydrate, and an insoluble compound of the aromatic body with the more stable form of the cellulose. Dilute nitric acid resolves the fibre into cellulose and a nitro-derivative

of the aromatic constituents, $n[C_{25}H_{21}(NO_2)_2O_{23}H_8]$. No constituent of the nature of pectose was found. From these facts the authors drew the conclusion that jute fibre consists of cellulose intimately associated with a complicated body allied to the quinones, in fact, a cellulide, after the type of the glucosides, the aromatic body being united to cellulose in place of glucose. They also observed that the chlorinated body when treated with a solution of sodium sulphite develops a magnificent purple colour; this reaction was applied for the detection of bast fibres. In the present paper the authors have continued this line of research. To the aromatic constituent of the jute fibre the authors assign the formula, $C_{19}H_{22}O_9$. The resemblance of this formula to that of catechin, $C_{15}H_{18}O_8$, suggested a comparative investigation of the latter substance; both catechin and catechu-tannic acid yielded a chlorine derivative resembling that mentioned above, which gave a brilliant magenta colour with sodium sulphite. Moreover, from a specimen of jute fibre which had become rotten through shipment in a damp state, a body was extracted by water having all the properties of tannin. Esparto resin, when fused with potash, furnished phloroglucin and much proto-catechuic acid. The general identity of these non-cellulose constituents with the class of astringent substances or tannins, is thus fully established. The authors then give details as to the bromine and chlorine compounds obtained from esparto resin. They next investigate the action of caustic alkalis on the chlorine derivative, $C_{19}H_{18}Cl_4O_9$, of jute fibre, by which action two atoms of chlorine were removed, as is the case with chloranil. By the action of bromine on jute fibre a brominated compound was obtained similar to that from esparto resin. As regards the constitution of these derivatives the authors are inclined to believe that their molecule is built up round chloranil as a centre. Chloranil when boiled with sugar, forms a brown substance, which behaves with alkalis and chlorine exactly like the aromatic substance obtained from bast fibres. The authors next consider the wider problem of the relation of the cellulose to the non-cellulose constituents of bast fibres, and the relation of both to the life of the plant. In these points they have been anticipated by the investigation and inferences of the physiological botanists, Sachs, Sachsse, &c., who have stated that cellulose is directly derived from starch, or its physical equivalents, sugar, fat, or inulin, and is not a product of the resolution of a proteid molecule; this formation of cellulose is attended with the evolution of carbonic anhydride. The chemical changes are expressed by Sachsse thus—



The molecule, $nC_6H_{12}O_6$, is then transformed into substances having the atomic ratio $C_6H_{10}O_5$. The formation of cellulose usually occurs in these portions containing no chlorophyll; the formation of starch, on the other hand, is associated with the presence of chlorophyll and the evolution of oxygen. The lignification of fibres originally consisting of pure cellulose is held by Sachs to be a modification of the cell substance (cellulose), and not an infiltration of substances from the contents of the cell. This change is expressed by Sachsse thus—



Sachsse thinks that it is to this more highly oxidised molecule, $C_6H_6O_5$, that the origin of the tannins is to be referred. The authors dissent from this equation, and think that bodies resembling meta-pectic acid, $C_8H_{14}O_9$, are formed. Such bodies have been found by Kolbe in linen fibre, and by the authors in the portions of the jute fibre near the roots (jute cuttings). Sachs maintains that the tannins are degradation products of cellulose, and are to be looked upon as excreta, like urea in the animal. If now the extreme terms of the developmental series are the celluloses and the tannins, it devolves upon the chemist to investigate the intermediate stages of the transformation. The authors therefore treated jute fibre

with dilute (5 per cent) sulphuric acid at moderate temperatures. As a result of these experiments they conclude that the jute fibre consists for the most part not of cellulose, but of a transition form between the original carbohydrate and its ultimate modification of a soluble astringent. To this transitional modification the authors give the name of *bastose*, as the authors consider there are many celluloses, so also there will be many forms of bastose. The aromatic derivatives derived from these bastoses the authors propose to call *bastins*. The authors then adduce various arguments to prove that the conversion of carbohydrates into aromatic bodies is possible. Thus Hoppe Seyler by heating starch to high temperatures with water formed pyrocatechin. Gun-cottons or nitro-celluloses degrade spontaneously into bodies of the pectic class, and the authors by the action of strong sulphuric acid on dextrin at 70°, obtained a black substance, which furnished a chlorinated product resembling in its properties the chlorobastin previously described. The formation of the black substance was accompanied with that of acetic and carbonic acids. The authors conclude the paper with the results of several miscellaneous researches bearing on the subject. The stony concretions of pears can be converted into cellulose and a chlorobastin giving the colour reaction with sodic sulphite. The origin of tannins, the reactions of jute substance under high pressure, the reduction of indigo by jute, the reaction of linseed oil with sulphuric acid, and additional observations on the chlorobastins, are the titles of these miscellaneous researches. The authors finally embody their results in a diagrammatic survey or genealogical tree. Carbonic anhydride and water by the action of light protoplasm and chlorophyll form starch. Starch and oxygen during the growth of the plant gives off CO_2 and H_2O , pectin and cellulose being formed. The starch passes through bastose to bastin. Bastose can be split up in various ways—by chlorine into cellulose and chlorobastin, by dilute sulphuric acid into furfural, acetic acid, &c., and tannins (insoluble), by decay into pectic acid and tannins (soluble), by nitric acid into cellulose and a nitro-body. Bastin, by fusion with KHO , furnishes phloroglucin and proto-catechuic acid, and by chlorination carbonic acid and chlorobastin.

The PRESIDENT congratulated the authors on having opened out a new field of research. The results seemed to him equally interesting and important, especially the connection between these bodies and the tannins.

Dr. GILBERT had listened with great interest to the paper. He hoped the authors would be able to continue the research, especially as to the conditions of plants in various stages of growth; such observations would be of the greatest advantage to physiological chemistry.

Dr. SCHUNCK had obtained some time back similar results as far as they went with cotton fibre. The subject was of interest both to science and technology. He was especially interested with the fatty and waxy matters.

Mr. CROSS then read a paper entitled "A New Apparatus for the Determination of Melting-points," by C. F. CROSS and E. J. BEVAN. The apparatus consists of a small platform of thin ferrotype iron or silver, having an opening for the reception of a thermometer bulb and a small indentation or depression about 1.5 m.m. deep and 2 m.m. in diameter. A very small quantity of the substance is melted in the little depression, and while still liquid a thin platinum wire, bent like an L and fused into a glass float, is immersed in the liquid and held there until the substance solidifies. A thermometer is then inserted in the opening, and the whole apparatus plunged under mercury. The mercury is gently heated, and the thermometer carefully watched. As soon as the substance melts the float rises instantly, and the temperature is noted. Stirring is unnecessary, the whole of the substance is surrounded with mercury, and the attention can be concentrated on the thermometer.

Dr. CARNELLY then read a paper "On the Action of Heat on Mercuric Chloride." About twelve months ago the author exhibited to the Society some experiments on

the action of heat on ice and mercuric chloride under low pressures, and subsequently read a paper on the subject before the Royal Society. Two propositions were advanced—(1) That when the superincumbent pressure is maintained below a certain point, called "the critical pressure," it is impossible to melt ice, mercuric chloride, and probably other substances, no matter how great the heat applied. (2) That under these circumstances ice and mercuric chloride attain temperatures considerably above their natural melting-points without melting. Subsequent observers have confirmed the first proposition, but have been unable to verify the second. The author has therefore repeated his previous experiments with mercuric chloride, and, in addition, has made determinations of the temperature of mercuric chloride, heated in a vacuum, by dropping the heated solid into calorimeters containing turpentine, benzene, and petroleum. Some unexpected results were obtained. When the salt is pressed as a compact powder round the bulb of the thermometer and heated in a vacuum, the thermometer rises 21° to 50° above the melting-point of the mercuric chloride, though still surrounded by the solid salt. When the salt is in the form of a solidified cylinder the temperature rises 15° above the melting-point. When a turpentine calorimeter is used the temperature of the mercuric chloride came out 100° above the ordinary melting-point; but with petroleum or benzene, temperatures above the ordinary melting-point could not be obtained. The author therefore withdraws his previous statement, and concludes that although mercuric chloride does not fuse when heated under diminished pressure, yet its temperature never rises appreciably above its ordinary melting-point, the high temperatures indicated by the thermometer being due to the diffusion of the superheated vapours of the mercuric chloride through the pores of the solid salt. The author also concludes that turpentine cannot be used in a calorimeter for the determination of the specific heat of bodies soluble in water, since some substances—such as mercuric chloride, zinc chloride, &c.—when heated cause an evolution of heat, due probably to the polymerisation of the turpentine. Hence many of Regnault's specific heat determinations, in which turpentine was employed, are probably too high; they are, it may be remarked, in almost all cases higher than Kopp's numbers, that observer having used coal-tar naphtha. The specific heat of mercuric chloride is 0.06425 , and of zinc chloride 0.14301 , neither value being altered by a rise of temperature.

The PRESIDENT complimented Dr. Carnelly on the energy and perseverance with which he had pursued the research, and explained the anomalies he had met with in its progress.

Dr. WRIGHT asked Dr. Carnelly if he had any chemical evidence of the polymerisation of the turpentine, and suggested that some experiments should be made with the mercuric chloride surrounded with a glass cylinder to prevent contact with the turpentine.

Dr. JAPP said that on boiling mercuric chloride with turpentine much cymene was formed.

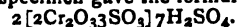
Mr. KINZETT stated that a somewhat similar action took place with zinc chloride.

Dr. CARNELLY, in reply to Dr. Wright, stated that he had not made any chemical examination of the turpentine.

"Contributions to the History of Cerium Compounds," by W. N. HARTLEY. This is an elaborate paper in seven parts:—I. "On the Preparation of Pure Cerium Salts." The author prepares these by the method of Mosander—*i.e.*, precipitating the mixed hydrates of cerium, lanthanum, and didymium by means of potash and soda, and converting the lanthanum and didymium compounds into hypochlorites by means of chlorine, the ceric hydrate being left insoluble. II. "A Delicate Test for Cerium." To a solution, either acid or neutral, a solution of sodic acetate and hydrogen peroxide are added. A brownish red solution results if cerium is present, which darkens considerably. Thus we can detect and even separate 1 part of cerium in 100,000 of liquid. III. "The Preparation and

Analysis of Cerous Phosphate." It has the composition $\text{Ce}_2\text{O}_3\text{P}_2\text{O}_5\cdot 4\text{H}_2\text{O}$. IV. "The Preparation and Analysis of Ceric Phosphate." This salt has the composition, dried *in vacuo*, $(\text{CeO}_2)_4(\text{P}_2\text{O}_5)_3\cdot 26\text{H}_2\text{O}$. V. "Note on the Composition of Edwardsite and Manazite." Edwardsite is a ceric phosphate. VI. "The Analysis of Rhabdophane, a New British Mineral." This mineral was discovered by Mr. G. W. Lettson. Two specimens existed in the collection of the late Mr. Turner, and two specimens have been discovered by Prof. Maskelyne in the Oxford collection. They were classed as blendes. Mr. Lettson, when examining various British blendes for gallium, recognised in the light reflected from this dull garnet-red translucent mineral the characteristic spectrum of didymium. The author has carefully analysed the mineral. It contains per cent—Water, 9.34; silica, 0.36; $\text{Al}_2\text{O}_3\cdot\text{Fe}_2\text{O}_3$ with P_2O_5 , 0.21; magnesium phosphate, 1.09; cerous oxide, 23.19; lanthanum and didymium oxides, 34.77; yttrium oxide, 2.09; P_2O_5 , 24.77. Its formula may be written $\text{Ce}_2\text{O}_3\text{Di}\cdot\text{LaO}_3(\text{P}_2\text{O}_5)_4\cdot 24\text{H}_2\text{O}$, in which the three metals Ce, Di, and La may wholly or in part replace each other. VII. "Spectroscopic Analysis of Rhabdophane." The spectroscope consisted of a Rutherford diffraction grating, ruled on speculum metal containing 17,460 lines to the inch. The author separated out a pure yttrium salt, and has carefully measured the lines in its spectrum and calculated their wave lengths. Yttrium has not hitherto been found in any British mineral. A group of four lines in the green, closely adjacent to each other, were seen, which could not be connected with the spectrum of any known element.

"On the Reaction of Chromic Anhydride with Sulphuric Acid," by C. F. CROSS and A. HIGGIN. The authors have analysed the insoluble chromium compounds formed in the above reaction. Their composition is somewhat variable. One specimen gave the formula—



"On Dibenxyl-anilin and its Isomerides," by A. HIGGIN.

The Society then adjourned to February 2, when a lecture "On the Unit Weight and Mode of Constitution of Compounds," will be delivered by Prof. Odling, F.R.S.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, November 24, 1881.

Mr. JOHN PATTINSON in the chair.

"On the Variation in the Composition of Steel Forgings." By T. W. HOGG.

Having some time ago made a series of analyses in order to ascertain whether there was any difference in composition between the centre and the surrounding material of a steel forging, and as these analyses are connected with a subject which has already attracted some attention, they have been connected together in the form of this short paper.

Although most of the following experiments were made about the time Mr. Stubbs, of Manchester, directed attention to this subject, I wish to submit them, as far as regards his observations upon the sulphur, phosphorus, carbon, and silicon, as an independent corroboration of his work, by an indirect method of experiment.

In the first of these experiments advantage was taken of an opportunity which offered itself of examining an old waste steel forging which had been made from an ingot containing impurities in considerable proportion. The diameter of this forging was $7\frac{1}{2}$ inches. It was formed from an ingot of about three tons in weight. A section having been cut out from this forging, borings were obtained from five points at equal intervals upon the face of it, as in figure.

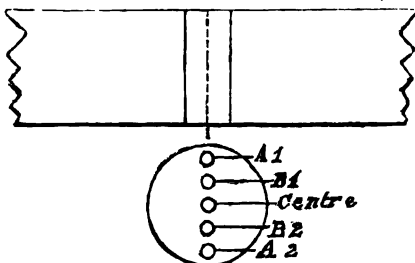
Analyses were made of the borings thus obtained, and the results are given in the following table, the marks corresponding to those in the sketch. In these and in all

the following analyses the greatest care was taken to obtain perfectly comparative results:—

	A 1.	B 1.	C.	B 2.	A 2.
Manganese	0·87	0·88	1·08	0·88	0·86
Carbon (by combustion) ..	0·67	0·66	1·20	0·64	0·66
Carbon (by colour test) ..	0·56	0·52	1·00	0·55	0·55
Silicon	0·14	0·13	0·18	0·14	0·12
Sulphur	0·11	0·09	0·24	0·11	0·10
Phosphorus	0·062	0·045	0·15	0·06	0·061

Total 1·852 1·805 2·85 1·83 1·801

thus showing that there existed in this particular specimen a remarkable accumulation of impure metal in the centre. In order to find where the variation ceased, a further



series of analyses was made of drillings taken from a similar section of the same forging at distances from the centre of $\frac{1}{4}$ inch, $\frac{1}{2}$ inch, $\frac{3}{4}$ inch, and 1 inch respectively.

Distance from the centre	$\frac{1}{4}$ in.	$\frac{1}{2}$ in.	$\frac{3}{4}$ in.	1 in.
Manganese	1·0	0·94	0·88	0·85
Carbon (by combustion) ..	0·87	0·66	0·66	0·68
Carbon (by colour test) ..	0·72	0·56	0·56	0·55
Silicon	0·15	0·15	0·13	0·14
Sulphur	0·15	0·11	0·8	0·10
Phosphorus	0·11	0·06	0·06	0·07

Total 2·28 1·92 1·81 1·84

These results show that the impure metal is contained within a radius from the centre of $\frac{1}{4}$ inch. More interesting information might have been obtained from borings taken from small drill holes and at small distances from each other, but the quantity of material so obtained is insufficient for analysis.

This difference in the composition is accompanied by characteristic differences in the appearance of the borings themselves; those obtained from the centre of the forging being very brittle and in colour very dark:—whilst in those coming from the parts marked A 1, A 2, B 1, and B 2, no essential difference from ordinary medium steel drillings is apparent.

Such a variation in the composition of this particular forging having undoubtedly taken place, it seemed interesting to ascertain whether ordinary steel forgings would be liable to the same action. For this purpose samples cut from five ordinary steel forgings were obtained. From each of these samples borings were taken from the centre, and also at a point about $\frac{1}{4}$ inches from the outside surface. These last (as shown by the analyses given above) will fairly represent the material surrounding the centre.

The analyses of these specimens are given in the following tables:—

1ST SAMPLE.—A FORGING $5\frac{1}{2}$ INCHES DIAMETER, AND FORMED FROM AN INGOT WEIGHING ONE TON.

	Centre.	Surrounding Material.
Manganese	0·58	0·48
Combined carbon	0·39	0·29
Silicon	0·047	0·015
Sulphur	0·11	0·041
Phosphorus	0·08	0·059

Total 1·207 0·885

Thus showing an increase of 0·3 per cent at the centre.

2ND SAMPLE.—A FORGING $7\frac{1}{8}$ INCHES DIAMETER, AND FORMED FROM AN INGOT WEIGHING 34 CWTs.

	Centre.	Surrounding Material.
Manganese	0·43	0·41
Combined carbon	0·24	0·14
Silicon	0·01	0·02
Sulphur	0·11	0·039
Phosphorus	0·07	0·048

Total 0·86 0·657

Impure metal is, therefore, present at the centre.

3RD SAMPLE.—A FORGING $7\frac{1}{8}$ INCHES IN DIAMETER.

	Centre.	Surrounding Material.
Manganese	0·36	0·37
Combined carbon	0·37	0·37
Silicon	0·031	0·023
Sulphur	0·064	0·053
Phosphorus	0·06	0·06

Total 0·885 0·876

This specimen, therefore, is homogeneous in its composition.

4TH SAMPLE.—A FORGING $7\frac{1}{8}$ INCHES IN DIAMETER.

	Centre.	Surrounding Material.
Manganese	0·53	0·43
Combined carbon	0·60	0·45
Silicon	0·13	0·10
Sulphur	0·096	0·05
Phosphorus	0·07	0·045

Total 1·426 1·075

Thus again we see that there is impure metal at the centre

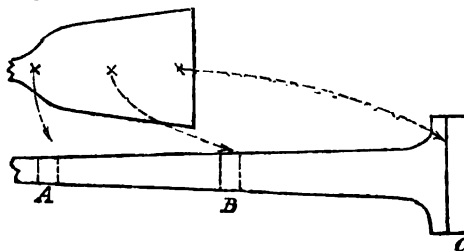
5TH SAMPLE.—A FORGING $12\frac{1}{2}$ INCHES IN DIAMETER.

	Centre.	Surrounding Material.
Manganese	0·27	0·25
Combined carbon	0·38	0·39
Silicon	0·023	0·054
Sulphur	0·060	0·062
Phosphorus	0·041	0·041

Total 0·774 0·797

This affords an example of a section of a forging homogeneous in its composition.

Here then are three out of the above five examples showing that the action indicated in the first series of analyses takes place even in an ingot one ton in weight, and two examples where the steel is practically homogeneous in composition. No explanation of this difference in the results suggested itself for some time until an opportunity occurred of obtaining cuttings from a forging. These cuttings corresponded to the part near the top, middle, and bottom respectively, of the ingot from which the forging was made.



The figure will make clear the position of the samples from which the following analyses were obtained, the

borings being taken as in the above samples, namely, at a point $1\frac{1}{4}$ inches from the outside surface and at the centre:—

(a.)—Section corresponding to the part near the top of the ingot:—

	Centre.	Surrounding Material.
Manganese	0.70	0.67
Combined carbon	0.36	0.36
Silicon	0.10	0.10
Sulphur	0.06	0.046
Phosphorus	0.061	0.052

Total 1.281 1.228

(b.)—Section corresponding to the part near the middle of the ingot:—

	Centre.	Surrounding Material.
Manganese	0.80	0.70
Combined carbon	0.56	0.37
Silicon	0.12	0.10
Sulphur	0.14	0.05
Phosphorus	0.12	0.054

Total 1.74 1.274

It is, therefore, found that in this part of the forging there is a considerable accumulation of impure metal.

(c.)—Unfortunately this sample was not from the same forging as the above, but was obtained from a similar one. It was 22 inches in diameter, and had received very little hammering, as will be evident from the sketch.

	Centre.	Surrounding Material.
Manganese	0.52	0.58
Combined carbon	0.40	0.40
Silicon	0.031	0.031
Sulphur	0.038	0.036
Phosphorus	0.064	0.061

Total 1.053 1.108

The manganese in this piece is slightly lower in the centre, otherwise the piece is quite homogeneous.

Another sample corresponding to the bottom of a similar ingot was obtained which had received a great deal of hammering, it being reduced to a diameter of 7 inches. This piece was examined at the centre of each end, and at a point $1\frac{1}{4}$ inches from the outside surface of one end only. The three analyses were practically alike, showing the perfect homogeneity of the piece.

These analyses, therefore, show that those parts of a steel forging corresponding to the part near the top and bottom ends of an ingot are homogeneous in their composition, and those parts of the forging corresponding to the middle of the ingot contain a core of accumulated impure metal, the extent of this accumulation depending upon the size of the ingot and the rate at which it cools.

This conclusion also follows from the observations of Mr. Stubbs, who, in addition, finds the impure metal to be nearer the top end of the ingot.

It does not seem probable that the existence of this slightly impure metal in the centre of a large forging can have any harmful influence upon it; but the fact should not be forgotten in the forging of large ingots to be cut up into billets for the production of the smaller articles in steel, for amongst these billets there will necessarily be some of very variable character. Of course this liability to vary will be reduced to a minimum by casting the ingots of as small dimensions as possible. In the analyses given about the samples corresponding to the top, middle, and bottom of the ingot respectively, the section corresponding to the top is shown to be practically homogeneous. The following analyses made in the same manner upon gits cut off from large castings corroborate this; the metal probably solidifies before any accumulative action can take place:—

GIT 8 INCHES DIAMETER FROM A STEEL CASTING.

	Surrounding Material.	Centre.
Manganese	0.62	0.62
Combined carbon	0.61	0.40
Silicon	0.39	0.44
Sulphur	0.045	0.048
Phosphorus	0.043	0.044

At the centre of this git part of the carbon had separated as graphitic or amorphous carbon which was not determined.

GIT 18 INCHES DIAMETER FROM ANOTHER STEEL CASTING.

	Surrounding Material.	Centre.
Manganese	0.46	0.41
Combined carbon	0.30	0.30
Silicon	0.25	0.25
Sulphur	0.053	0.057
Phosphorus	0.053	0.057

It is interesting to notice that Chernoff many years ago proved the structural inferiority of the upper ends of large ingots, even in those which have been submitted to considerable compression; so that the forging, through the hammering it has received, may appear to be quite sound, and the analysis may indicate the chemical homogeneity of it, yet it will be greatly inferior to the part corresponding to the bottom of the ingot. Advantage may be taken of this fact, and material may be obtained for special purposes from the bottom part of the ingot, homogeneous both in structure and in composition.

Attention may be drawn towards the fact that the manganese in these analyses increases with the other elements and does not decrease with the iron; but Mr. Stubbs concludes, and recently Mr. Snelus confirms his conclusion, that in the ingot itself the reverse is the case.

As was mentioned at the commencement of the above analyses, the greatest care was taken to make the results strictly comparative. However, in order to satisfy myself of the accuracy of these comparative determinations, three separate analyses were made upon different quantities of the steel from the centre and from A 1 (first series of analyses), these analyses being made by three different modifications of the ordinary acetate method. The results were:—

	A.	B.	C.
Borings from centre ..	1.10	1.08	1.06
Borings from A 1	0.90	0.87	0.88
Increase in the centre	0.20	0.21	0.18

It is to be hoped that those having an opportunity of repeating these experiments will carefully examine this point in connection with the manganese.

In conclusion, I have to thank Messrs. J. Spencer and Sons for their permission to communicate these analyses

The CHAIRMAN—The paper is very interesting as confirming the results of Mr. Stubbs and Mr. Snelus. I was at the meeting when Mr. Stubbs made his remarks, and it recalled some experiments which I made several years ago on pig-iron with a similar object. I took samples from the top and bottom of a large ladle containing pig-iron, and determined the impurities in each, paying especial regard to the phosphorus. I failed to find any difference between the two; but, of course, I was dealing with a very different material from steel (containing about 1.5 per cent. instead of about 0.05 per cent. of phosphorus), and our methods of determining phosphorus were not then so delicate as they are now. Mr. Stubbs showed that in the long vertical ingots which they cast the impurities seemed to concentrate in a small part near to the top of the ingot; those parts which cool quickly seem to be tolerably homogeneous. Mr. Snelus has pointed out a remarkable confirmation of these results in some experiments at Wool-

which, in which it was shown by the tensile strain and other mechanical tests that those portions of the ingots where the impurities tend to concentrate were of inferior quality to the rest. Since Mr. Snelus's discovery of the principle on which phosphorus can be eliminated from pig-iron in the Bessemer converter, still further developed by Messrs. Thomas and Gilchrist and others, the great principles of dealing successfully with the impurities of pig-iron have been mastered. With such experiments as Mr. Hogg has laid before us we are now getting into the refinements of steel manufacture. They are of great value in increasing our knowledge of the properties of this valuable metal, and in throwing light on some of the causes of unexpected failure in steel plates and other large masses of steel.

A vote of thanks to Mr. Hogg terminated the proceedings.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

December 5, 1881.

MR. ROBERT R. TATLOCK, President, in the Chair.

Dr. Wallace's Address.

(Concluded from p. 33.)

WE now come to a division of our subject which is not chemical but physical, but which is nevertheless closely connected with the dissociation of compound bodies. We have in nature three states of matter—solid, liquid, and gaseous; but these are merely accidental conditions, as I shall attempt to show you, determined partly by the nature of the bodies themselves, partly by the particular temperature and pressure to which they are subject. I think you will have no difficulty in accepting the axiom that all solid bodies are capable of being liquefied, if we except a comparatively small number which pass at once from the solid to the gaseous state, such as metallic arsenic, some of the compounds of arsenic and of mercury, &c. Platinum, which resists the heat of our ordinary furnaces, melts like wax before the oxy-hydrogen flame; and in a crucible of pure lime—as suggested by Deville, and wrought out practically by Johnson, Matthey, and Co., of London—pounds, I might almost say hundredweights, of it can be fused with as great facility as the plumber melts lead in an iron ladle over a chauffer. Iridium, which is more refractory than platinum, may be melted also by the oxy-hydrogen flame; and all metals, without exception, cease to retain their solid form when placed in a voltaic circuit of such quantity and intensity that they cannot pass it without resistance. We are familiar with one liquid metal, mercury; but at a temperature of -40° F. it is a malleable solid, not unlike lead; while at 650° it is gaseous and indistinguishable in appearance from air or any other gas. Again, we are equally familiar with metals—potassium and sodium—which are soft to the touch, and can be cut with a penknife with the greatest facility. They are, in fact, at the temperature of this earth, in the plastic condition to which iron is reduced when brought up to a welding heat, and which platinum assumes far below its point of fusion. These metals, which when cut have the brilliancy of the most highly-polished silver, melt below the temperature of boiling water (136° and 190° F.), and become hard when exposed to intense cold. Tin melts at a comparatively low degree of heat (442° F.), so do lead and zinc (617° and 773° F.)—the latter assuming, a little below its melting-point, a brittle condition, in which it may be reduced to powder in a mortar, while a little lower (200° to 300° F.) it assumes a highly malleable state, in which it is readily rolled into the sheets with which we are all familiar. It is worthy of note that many metals and other solids in melting contract in bulk, and in solidifying expand. Thus, ice floats on the top of water, having a gravity, as compared with water=1000, of 920. It was at one time supposed that water in this respect occupied

an anomalous position, but recent experiments—some of them made by members of this Society—have conclusively shown that in a great many cases, when the solid form of the body is at or near the temperature of its liquid condition, it floats on the surface in consequence of its lesser gravity. It is true that a cold pig of iron, thrown into a molten mass of the same metal, will sink to the bottom of the vessel, but as it becomes assimilated in temperature to the liquid metal it rises to the surface. A similar experiment made with trap rock shows that, in this case also, there is contraction in fusing the mineral and expansion in cooling the fused mass. In like manner we could, by exposing ice to an intensely low temperature—thus contracting its volume and increasing its relative density—cause it to sink in water, which might be heated to decrease its specific gravity. The explanation of this phenomenon is probably that, in assuming the solid state, the atoms or molecules take a geometric form, in which they occupy more space than they do when in a free condition of molecular movement, as they are when in the liquid state.

All liquids are capable of being boiled or converted into gases or vapours by heat, the only exceptions being in the case of those compounds which, on being heated, suffer decomposition. It is equally the case with solids, with the same exception, so that the gaseous form may be regarded as the normal condition of matter. There are many solid bodies which we have not actually as yet converted into gas, and we are compelled to fall back on analogies for proof of our proposition. The liquid metal, mercury, can be distilled like water, although the temperature required is considerably higher; potassium and sodium are converted into vapour with almost equal facility, and zinc is regularly distilled in the commercial production of that metal from its ores. Lead also is distinctly volatile, and no metal, however refractory, can be kept long at its melting-point without suffering some loss of weight. Iron is readily volatilised in part by the heat generated by its own combustion in oxygen gas. Arsenic on being heated sublimates, passing at once into the gaseous condition without assuming the liquid form. Gold, which requires a rather high temperature for fusion, is at once dissipated in the gaseous state by an electric discharge of high tension; and silver, platinum, copper, iron, and many other metals are vapourised instantaneously with equal facility. With regard to carbon, there can be little, if any, doubt in the minds of scientific men that it is converted into vapour in the electric arc, and that without necessarily undergoing combustion, for the phenomena are not sensibly altered when the experiment is made in an exhausted receiver, or in a vessel filled with an inactive gas, such as nitrogen. It may be said that the transference of carbon from the one pole to the other is simply mechanical, and consists of solid particles detached from the one and carried to the other; but that explanation does not suffice to account for the observed facts, and we are driven irresistibly to the conclusion that there is a partial volatilisation of the carbon. The chemist talks of compounds, such as marsh gas and carbonic oxide, as containing so many volumes of the other elements; but I need scarcely say that the combining volume of carbon is deduced, on theoretical grounds, from the volume of its compounds and comparison with analogous cases. Still, that carbon is capable of existing in the free state as a gas or vapour will scarcely be disputed. So with all other elements, and so with all chemical compounds, with or without previous re-solution into their constituent elements. What we cannot prove by experiment we must still accept as the only rational conclusion to which we are led by analogy and reasoning.

We now come to the converse view of the matter. Most liquids can readily be made to assume the solid form. There are, it is true, some organic liquids—of which alcohol may be taken as a type—which have never yet been frozen; but even in these cases we have seen the liquids assume, in the extreme rigour of an Arctic winter, an oily consistency, which is no doubt an approach to the solid form which would be attained by the application of

a temperature sufficiently low. As regards the gaseous condition, the treatment of the subject requires a little more consideration. Formerly we were in the habit of speaking of *permanent* gases as distinguished from others which had liquefied, such as sulphurous and carbonic anhydride, chlorine, cyanogen, and so on; and we also spoke of the vapours of water, alcohol, mercury, and other volatile liquids as if they were something different from gases. All that has been changed by the splendid experimental researches of Cailletet and Pictet, by whom the so-called permanent gases—oxygen, hydrogen, and nitrogen—have been liquefied. In the case of hydrogen, which has long been considered to fulfil the functions of a metal, it was liquefied by Pictet under a pressure of 650 atmospheres, or upwards of 4 tons on the square inch,* and a temperature of -170° C., or -274° F.; and, in escaping from its confinement, the further reduction of temperature caused by its re-assumption of the gaseous state sufficed to solidify a portion of the liquid, and the particles fell to the floor, to quote the experimenter's own words, with "the shrill noise of metallic hail." Hydrogen, or, as we should perhaps call it for the sake of uniformity, hydrogenium, is really a metal after all, and it is only an accident of temperature and pressure that prevents it from possessing the ordinary metallic properties with which we are familiar in lead, silver, or platinum.

The difference between solids, liquids, and gases is simply a question of temperature, or, in other words, of molecular motion. In liquids and gases we have, according to the generally accepted kinetic theory, a constant movement of the atoms or molecules, the rate of which differs in the case of each individual gas. It is difficult to define the exact difference between gases and liquids; both possess, to a very large extent, the same functions, and many gases can be converted into liquids by pressure alone, and independently of reduction of temperature. In like manner, if we place a liquid in a confined space and seal it up we can convert it entirely into gas by exposing it to a sufficiently high temperature, provided there is enough space for the expansion of the liquid before it is converted into gas. A cubic inch of water becomes, under ordinary circumstances, a cubic foot of steam or gaseous water; but the water may be converted into gas in a confined space of less than two cubic inches. Many of the experiments on the relations of gases to liquids have been conducted with carbonic anhydride, which, under ordinary temperatures, is liquefied under a pressure of about 50 atmospheres. The researches of Andrews, of Belfast, are particularly noteworthy, and are well known to all physical and chemical philosophers. He was the first to observe what is called the "critical point" of a liquefiable gas, a point at which it is difficult to say whether the body exists as gas or liquid; or, rather, we may have both forms existing in the same vessel, but without any distinct line of separation—in fact, they seem to merge into one another. The critical temperature varies with the pressure, and in some gases it is far below zero of Fahrenheit's thermometer. Still, under ordinary circumstances, the physical characters of gases and liquids are sufficiently well marked, besides which we have in the change of state from liquid to gas a large amount of heat rendered latent, and in the contrary action a similar amount of heat becoming sensible.

It is, perhaps, superfluous to dwell further on this interesting subject; but I would like to impress this fact on your minds, that the atoms of matter are the same whatever be the physical condition. In solids, as I have already hinted, the atoms are probably arranged in molecules of symmetrical geometric form. The simplest geometric form is the tetrahedron, in which case only four atoms would be required to form a molecule; but probably there are few molecules so simple, and there is reason to believe that many of them are highly complex, especially the molecules of compound bodies. Crystalline forms,

such as we produce by fusion and cooling, by solution and evaporation, or by sublimation, are probably aggregates of the symmetrical molecules; at least we know that some crystals, such as those of Iceland spar, are built up of myriads of smaller crystals of exactly the same form. There are many solids which have two or more distinct forms, which often possess specific properties. Sulphur is one of them; it has at least two distinct crystalline forms, and one that is amorphous. In these various modifications we can readily conceive that the atoms in the molecules are differently arranged, and probably different in number, and that in the amorphous state symmetry is absent, and the atoms are not grouped into molecules, but are free and distinct as in liquids, although destitute of motion. Silica affords an excellent illustration of trimorphism. There is the familiar variety known as rock crystal, the form of which is a six-sided prism, and it has a gravity of about 2.6. Another crystalline form, "Tridymite," has a gravity of 2.3, while the ordinary amorphous quartz is only 2.2. All these modifications may be formed by deposition from solutions, but at different temperatures. Sometimes one crystalline form may be transformed into another by the simple application of heat, and the change becomes apparent by some modification of colour or some other property. Thus the scarlet iodide of mercury, when gently warmed, acquires, together with a new crystalline form, a pale yellow colour, which gradually and slowly comes back to the normal tint, which may be more rapidly brought back by friction. Again, the brick-red double iodide of mercury and copper changes to black at the temperature of boiling water, the red colour being restored on the removal of the source of heat. Calcic carbonate has two very distinct crystalline forms, one of which, the rhombohedron, is well known in the mineral form of Iceland spar; the other, a six-sided prism, is seen in aragonite. Now, if a crystal of aragonite is suddenly heated, it falls into a rough powder, which, on examination with a microscope, is seen to consist of minute crystals of Iceland spar.

In liquids and gases we may assume, with some degree of probability, that the atoms are in most cases not grouped into molecules, at least in the case of elementary bodies. In these two forms of matter the atoms are in motion, but the motion is more rapid in gases than in liquids, in the former having what is called a free path, in which they move a considerable distance, compared with their own dimensions, without encountering one another; while in the latter they are constantly coming into collision. The great difference between liquids and gases is that in gases, unless at or near the critical point, the atoms are further apart than in liquids, other circumstances, as of pressure and temperature, being equal. In the case of hydrogen gas, at ordinary temperature and pressure, it has been calculated that the atoms move at the rate of 6225 feet per second, their size being at most 1.5 millionth of an inch in diameter. The rate of motion, however, is influenced both by temperature and pressure.

The atoms of gases are inconceivably minute, and the distances between them, although necessarily very far in excess of the dimensions of the atoms themselves, are also infinitely beyond our powers of perception. In regard to water, we cannot tell the absolute distance of the atoms in steam, but we know this much, that they are twelve times farther apart in every direction than they are in water—a cubic inch of water giving a cubic foot of steam. But gases are different from solids and liquids in being infinitely more readily affected by temperature and pressure. They possess the property of idio-repulsion, which causes their atoms to separate further and further as the pressure is reduced. I am not sure that there is really such a force as idio-repulsion, but it is true, at all events, whatever be the correct explanation of it, that as the pressure decreases the volume increases, and this without any apparent limit. It has been argued that, if matter consists of atoms, it follows that gases have a limit of expansion, beyond which they cannot pass. But it has

* It will assist the comprehension of this enormous pressure when it is stated that it is equal to that exerted by a rod of iron 2900 ft. high.

really nothing to do with the atomic theory, for it is not a question of the infinite divisibility of matter or the reverse, in regard to which there is at the present day no manner of doubt in the minds of chemists and physicists, but simply of the separation of atoms further and further apart. In the experiments of Gassiot and Crookes, gases have been reduced to a most extraordinary degree of tenuity, and perfect vacua have been obtained—perfect, at least, as regards the particular gases with which the vessels were filled, the last traces being absorbed by chemical agents. For my own part, I cannot conceive of any limit to the distance to which the atoms of a gas may be separated, any more than I can conceive of a limit to space itself. In regard to the atmosphere which surrounds our earth, it probably becomes so attenuated at a distance of about forty miles as to be scarcely appreciable in gravity; but there are really no good grounds for supposing that it is limited to 40, 50, or even 200 miles, or that it does not in some degree fill all space, at least within our solar system. But it is impossible to stop here; if this is so, it follows, almost as a matter of course, that the same space contained at one time—a distance of time that it is as impossible for us to realise as it is for us to form a distinct conception regarding the dimensions of space itself—all the elements which we find on the earth's surface, in the planets, in the comets belonging to our system, and in the sun.

It is well known that if we descend into the earth we soon reach a point at which the temperature is practically constant, affected, to an appreciable extent, neither by the heat of summer nor the cold of winter. This point of constant temperature varies in different parts of the world, but in this country it is about 50 feet from the surface, and is about 47° F. But, if we descend beyond this point by means of a pit or mine, we find a decided increase of temperature the further we descend; and this increment of heat goes on to the greatest depths which have been reached, either by actual descent into the bowels of the earth, or by boring for water to still greater depths. The rate of increment varies at different places from 50 to 100 feet for each degree Fahr. It is, therefore, a natural conclusion that there exists an internal source of heat, which is constantly passing outwards and being dissipated into space. The existence of volcanoes, and of rocks which bear unmistakable evidence of having been in a state of fusion, point to the same conclusion; and it is only a further step to understand that the earth was at a former period in a complete state of fusion, and that it has been gradually cooling ever since. With regard to the question whether there is an internal mass of *fluid* towards the earth's centre, that is a matter which is open to discussion, and which cannot be determined by actual observation. If the increment of heat which we find in descending some hundreds of feet in a pit were continued at the same ratio for a depth equal to only 1-50th of the earth's radius, or about 80 miles, nearly all bodies with which we are acquainted would be in a state of fusion. As regards volcanoes, there is at least a probability that their occurrence is due in many instances to local causes, and that they are not necessarily connected with an internal igneous mass. In passing, I will only make this one observation in regard to the geology of the earth's crust, that some of the rocks which were formerly considered to be of igneous origin, have, upon further study, been declared to have been deposited from water. Even the granite, which Murchison used to speak of as the backbone of our native land, must, I fear, be relegated to the group of metamorphic rocks, of which it is, however, probably the most ancient.

The earth at one period was a fluid mass, cooled gradually by radiation; and, after a time, a crust was formed on its surface. But as this crust, itself a very bad conductor of heat, grew colder towards the surface, contraction must have taken place, and irregular fissures produced, giving rise to catastrophes of various kinds, and especially the formation of mountain ranges. Neither

can we suppose that the fluid mass was perfectly quiescent: on the contrary, there is every reason to suppose that chemical action was going on, giving rise to the formation of gaseous matter, which found vent in the craters of volcanoes. In course of time the earth became so cold that the aqueous vapour contained in the atmosphere condensed, and a new series of phenomena commenced, one result of which was extensive denudation and the formation of the sedimentary rocks, some of which must have been formed at inconceivably remote periods. The upheavals of the earth's crust, to which I have referred, certainly continued long after the condensation of water, for we find sedimentary rocks high up in the most lofty of our mountain chains; and they occur even at the present time, although in a modified form, and only in certain circumscribed localities.

But, remote as the period of perfect fluidity undoubtedly was, it is a fair and legitimate conjecture, if I may use that word in regard to a matter which scarcely admits of a doubt, that it was preceded by one yet further removed in the dim vista of the immeasurable past. It is true that we are absolutely incapable of contemplating a commencement of the existence of the universe, just as we cannot conceive of the beginning of time, the duration of eternity, or the bounds of space; but if we follow up the thoughts in which we have been indulging, we seem to come unavoidably to a period in which that form of motion which we call heat reigned supreme, in which all matter was gaseous and elementary. How that matter came to be condensed and aggregated into groups, forming a central sun, planets and their satellites, comets, aerolites, and meteoric dust, I shall not attempt to conjecture; but I shall ask you to follow me in a speculation which I trust you will not consider too daring or presumptuous. The cooling effect of radiation on these aggregations of vapours would probably result, in the first place, in the chemical union of the various elements, especially the metals and hydrogen, with oxygen; and as this combination would set free heat formerly latent in the elementary bodies, there would, for a long time, be a period of oscillation between compounds and elements, during which the cooling process would go on with extreme tardiness. Merging imperceptibly into this period of chemical combination would be that of liquefaction of the compounds and the few elements, such as gold and platinum, which possess only slight affinities for the other elements; with a residuum of oxygen and nitrogen gases, and steam more or less mixed with other vapours. Then would follow a period of comparative quiescence; combustion, that is, the combination of the elements, would cease, and enormous contraction in bulk would follow, and the orb would be, to use a vulgar phrase, played out as a source of light to surrounding heavenly bodies, and would soon become covered with a solid crust, which would render it comparatively inoperative as a centre of heat radiation. Then would follow the various phenomena which I attempted to describe as having been experienced in our own little planet; and, if we were to pursue the speculation further still, we should reach a point in the future as dim and distant as the events I have alluded to were in the past, in which sun, earth, and moon, not to speak of the innumerable suns belonging to other systems with which the sky is studded, will be cold and lifeless as the impenetrable ice-barriers of the Polar regions. But surely these are not mere speculations; are they not going on before our eyes at the present time? Is not our own earth in the stage of cooling down after having completed its period of active incandescence? and is not the sun at this very moment undergoing the combination of its elements which has gone on for ages, and will go on for ages to come? What are the solar prominences but gigantic flames of hydrogen in the act of combination with oxygen, and the photosphere but an almost transparent film of gaseous matter undergoing combustion; while the nucleus is still composed of matter at too high a temperature to admit of chemical combination between its elements? And is not

the chromosphere, which gives us the Fraunhofer lines in the solar spectrum, the gaseous or vapourised products of combustion of hydrogen and the various metals which in the body of the sun exist as gases, but condensed to comparatively small bulk by enormous pressure?

The gravity of the earth is about 5·6, which is about twice that of granite, and $1\frac{1}{2}$ that of trap rock. The weight of the sun, as compared with water, is only one-fourth that of the earth; and as the constituents, as determined by the spectroscopic, are essentially the same, while the effects of gravitation are enormously in excess of those observed on the earth's surface, it is a fair inference to conclude that when, in future and far distant ages, the heat generated by the combination of its elementary constituents, and that derived from the changes of state from gas to fluid and from fluid to solid, will have been dissipated into space, its bulk will have so far contracted that its gravity will at least equal that of the earth.

Gentlemen, the subject of chemical dissociation, to which I essayed to call your attention this evening, has led me imperceptibly to treat of matters which have long been floating in my mind, but to which I have not hitherto ventured to give expression; and I have to crave your indulgence for the exceedingly crude and imperfect way in which I have placed these views before you, and also for having failed to notice other theories which have been advanced for the explanation of the phenomena of solar heat and light. We live in a time of rapid progress in scientific research, and talk familiarly of matters of momentous import, which our fathers never dreamt of. Let us see that we be not puffed up with our knowledge—which, after all, is trifling compared to what mankind may yet attain to—but ever struggle on, humbly and hopefully, in the earnest desire to learn something of the mysteries of that glorious world in which we are such insignificant units.

A very interesting discussion followed, in which Mr. Macfar, Dr. Dobbie, Mr. Whitelaw, Mr. Stanford, Mr. Coleman, and Mr. Mayer took part.

A hearty vote of thanks having been proposed to Dr. Wallace, the meeting closed.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 3.

The Separation of Cadmium.—E. Donath and J. Mayrhofer.—The statement of Ditte that cadmium sulphide is appreciably soluble in ammonium sulphide is unfounded. Cadmium sulphide precipitated with ammonium sulphide passes even through a double filter. Hence sodium sulphide should be used if cadmium is present.

New Reaction for the Detection of Sulphur and Nitrobenzol.—R. Brunner.—The substance to be examined is mixed with a little strong potassa-lye, a few drops of commercial nitro-benzol and of alcohol are added, and the mixture is allowed to stand at the common temperature, with occasional stirring. After some time, if sulphur or an alkaline sulphide is present, there appears a red colouration, due to the reduction of nitro-benzol. In this manner, both free sulphur and the sulphur present in white of egg, in bread, wool, &c., may be directly demonstrated. An inversion of the process may serve for the detection of nitro-benzol.

Detection of Small Quantities of Cobalt and Nickel, simultaneously present.—E. Donath and J. Mayrhofer.—The precipitate obtained in a systematic

analysis which may consist of nickel and cobalt sulphides is dissolved in a minimum of nitric acid, mixed with an excess of soda-lye, and a corresponding quantity of solid iodine, and boiled. If little nickel and much cobalt are present the precipitate is brown or brownish black, granular, and loose. In the opposite case it is either like pure nickelous oxide or of a dirty greyish green; it is filtered, washed with hot water, and introduced into a test-tube by perforating the filter. Here it is shaken up with ammonia and a few drops of ammonium chloride solution and filtered. The filtrate, which can only contain nickel, is mixed with a few drops of ammonium sulphide. An immediate dark brown colouration followed by a black precipitate, shows the presence of nickel. The residue upon the filter is several times drenched with ammonia, thoroughly washed with hot water, dissolved in a few drops of hydrochloric acid, and the solution boiled with a fragment of solid potassa. After the precipitate has subsided, the blue colour of an alkaline cobaltate is observed, which is soon decomposed, with a deposit of brown cobalt oxid.

The Ash of Coke.—A. Wagner.—A reply to a paper by Dr. Muck, in which the latter attributes to the author views which he entirely disclaims.

A New Test for Potassa.—L. L. de Koninck.—If a 10-per cent solution of sodium nitrite is mixed with cobaltous chloride and acetic acid, the liquid forms a reagent for the detection of potassa, much more sensitive than platinum chloride. An immediate yellow precipitate is obtained in a solution containing 1 part potassium chloride in 100 parts of water. It is still perceptible if diluted to 1 : 1000, but in the proportion 1 : 2000 a precipitate is no longer obtained. Ammonia gives a similar but much less sensitive reaction; the salts of magnesium, calcium, barium, strontium, iron, aluminium, and zinc are not precipitated by the reagent. The author is endeavouring to found a quantitative process upon this reaction.

Determination of the Specific Gravity of Liquids.—L. Weber.—The author takes two U-tubes of equal width, each with a short and a long limb, connects the two short limbs by means of a caoutchouc tube, and pours into one of the long limbs water, and into the other the liquid to be examined. The liquids stand higher in the long than in the short limbs, and the differences of level will be inversely as the specific gravities.

Behaviour of Platinum Crucibles on Ignition.—H. Beilstein.—New crucibles suffer a greater or less decrease in weight when heated, but after repeated ignition such changes no longer occur.

Preparation of Hydriodic and Hydrobromic Acids.—C. Winckler.—The author uses a solution of iodine in carbon disulphide. Over this is a stratum of water, and hydrogen sulphide is introduced as usual. The method is applicable for hydrobromic acid, but with less distinct advantage.

Detection of Alumina.—M. Beckmann.—The author recommends baryta water in place of soda-lye, as not being contaminated with alumina and silica. Solution of ammonium chloride is added afterwards, as usual.

MISCELLANEOUS.

Popular Science.—In a morning paper for the 17th inst. we find a list of explosives mentioned as used on ship-board, among which figures one under the name of "sodium of calcium."

The Royal Society of New South Wales.—(*Original Researches.*)—The Royal Society of New South Wales offers a prize for the best communication, containing the results of original research or observation, upon each of the following subjects:—

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MEETINGS FOR THE WEEK.

- MONDAY, 30th.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.
TUESDAY, 31st.—Institute of Civil Engineers, 8.
— Royal Institution, 3. "The Mechanism of the Senses," Prof. J. G. M'Kendrick.
— Society of Arts, 8. "The Social and Physical Capacities of New Zealand for Tea and Silk Cultivation," by William Cochran.
WEDNESDAY, Feb. 1st.—Society of Arts, 8. "Stained Glass Windows," by Lewis Foreman Day.
— Pharmaceutical, 8.
— Obstetrical, 8. Anniversary.
THURSDAY, 2nd.—Royal, 4.30.
— Chemical, 8.
— Royal Institution, 3. "Corals," Mr. H. N. Moseley.
— Royal Society Club, 6.30.
FRIDAY, 3rd.—Royal Institution, 8. "Action of Molecules, Free and Constrained, on Radiant Heat," by Professor Tyndall, 9.
— Geologists' Association, 8. Anniversary.
SATURDAY, 4th.—Royal Institution, 3. "Ludwig van Beethoven," by Prof. Pauer.

TO CORRESPONDENTS.

R. Neman Redmayne.—A notice of the book on Coal appeared in the CHEMICAL NEWS, vol. xlv., p. 285.

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	Peroxide of Iron	0'47	1'57	4'57	
	Silica	18'00	8'67	12'00	
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	Lime, Magnesia, Potash, Soda, and Sulphuric Acid	0'23	0'83	1'14	
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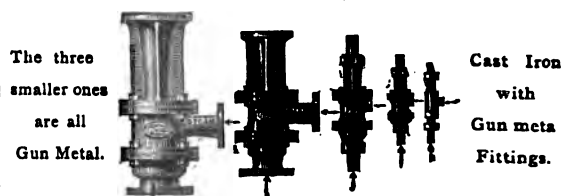
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THE CHEMICAL NEWS

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ON MANURE PHOSPHATES.

By K. WALTER, Chemical Engineer, Auvelds, Belgium.

WHEN I wrote my last article on this subject in the *CHEMICAL NEWS*, vol. xxxviii., pp. 37, 50, I could not have imagined that it would take such a long time before the analysis of those phosphates by the method of citrate of ammonia would be generally adopted. The more, as I know, that the greater number of English agricultural chemists are convinced that the phosphoric acid soluble in the citrate, is equal in value to the phosphoric acid soluble in water.

Professor Petermann, in Gembloux, Chief Manager of the Belgian Royal Agricultural Stations, had in 1877 officially announced that from January 1, 1878, all the phosphoric acid soluble in the citrate of ammonia would be counted at the same rate as the former soluble in water. In short, any sample of superphosphate would no more be valued on its contents of phosphoric acid soluble in water, but only on its contents of phosphoric acid soluble in the citrate of ammonia. To this latter process was then given the term determination of *assimilable* phosphoric acid.

Neither manure manufacturers nor agriculturists made the slightest objection to this innovation, because everybody found himself well off by it; and to-day it has so much become the custom, that neither party appears to think that it has ever been otherwise. The more so, as the repeated trials of latter years have clearly shown the superiority of precipitated phosphate (retrograded phosphate) to the superphosphate. All the experiences of Toulie, Grandean, Petermann, and many others, are, by the trials of late, confirmed to evidence.

As soon as the decision of Dr. Petermann was known, the German superphosphate manufacturers took up the matter, and tried with all their might to introduce the same system into Germany; but they found it not as easy as they had a right to believe. There were some eminent agricultural chemists who were perfectly of the same opinion as Petermann, and fought by word and writing for the same cause; but the greater number of them, including some of the most influential, were thoroughly against it.

The German Professors never could pardon Petermann, that he had taken, as one of them (Petermann is German), such a measure without first having demanded and obtained the high permission and assent of united sage agricultural Germany.

However, some of them were honest enough to begin to try the matter by experience, and at this period, even the most inveterate opponents of Petermann's system were obliged to come over. It was generally admitted that the phosphoric acid soluble in the citrate has at least the same value as phosphoric acid soluble in water, *for those kinds of soils in which the experiments were made*. They concluded that further experiments must show if the equality is evident in all kinds of soils.

Anyhow this was a great step forward—by which German superphosphate makers have profited. They have begun to count the phosphoric acid soluble in citrate—*en attendant*—at half the price, as that soluble in water. There can, however, not be the slightest doubt that in a time very near to come, the same system as used in Belgium and in France will be adopted in Germany; at all events, manure makers there do their utmost to bring things to this solution.

It is altogether inexplicable that the English manure

manufacturers—by far the most interested in this question—did not take serious steps to follow the same road. The quantities of superphosphate made by the English works is so very important that those manufactured on the Continent are a mere nothing against it. The English superphosphate manufactory loses annually hundreds of thousands of pounds by persisting in their present system—and this in times in which the chemical trade cannot afford to make any superfluous losses which easily might be avoided.

Every experienced superphosphate maker knows that even the purest raw phosphates (containing only traces of iron and alumina) give superphosphates, which contain $\frac{1}{2}$ to 1 per cent of phosphoric acid not soluble in water but easily in the citrate of ammonia. Most phosphates, however, used for the trade in question, give superphosphates containing in a fresh state $1\frac{1}{2}$ per cent of phosphoric acid not soluble in water but in the citrate. After storing of three to four months' duration, this latter amounts to 2 to 3 per cent, and sometimes even more—of course to the detriment of the phosphoric acid soluble in water.

If we take superphosphate, on an average, as containing 14.5 per cent phosphoric acid soluble in citrate, or 13 per cent phosphoric acid soluble in water, $1\frac{1}{2}$ per cent are lost for the English manufacturer. That is to say for the whole quantity of phosphoric acid rendered soluble for sale and available for agricultural purposes, 10 per cent. A manufacturer making per year 3000 tons of superphosphate actually loses about £1200 annually.

It is certainly no advantage for the agricultural chemists to exchange the handy analysis of phosphoric acid soluble in water, against the more complicated and tedious one of phosphoric acid soluble in the citrate.

They were, however, obliged to do it on the Continent, and the English chemists will have to follow, sooner or later. This mode of analysis has now arrived at such a perfection that the results of the different chemists, when they follow the same method, are most satisfactory, and just of the same accordance as the analysis of phosphoric acid soluble in water. In the International Congress of Agricultural Chemists, held at Paris last summer, the manner of analysis was fixed for the rest.

I will now narrate in as few words as possible the comparative results, given by a great series of trials in different parts of Belgium, Germany, and France, between the superphosphate monobasic phosphoric acid and the precipitated (retrograded, gone-back) phosphoric acid, *considered* to be bibasic; the first soluble in water, the second soluble in citrate of ammonia.

1. In heavy clay soils, the phosphoric acid soluble in water has the same effect as phosphoric acid soluble in the citrate, sometimes even a trifle better.
2. In soils rich in humus, limestone soils, slaty soils the effect of the second is *at least* the same as that of the first.
3. In light, sandy soils, the effect of phosphoric acid soluble in water is surprisingly inferior to that of phosphoric acid soluble in the citrate.

In short terms, the one is worth as much as the other as a *general rule*, but the intelligent farmer will take his choice in consequence of the soils he has to deal with. In the latter years experience has shown that in light, sandy soils, even precipitated phosphate dried at a very high temperature, and in consequence only containing traces of phosphoric acid soluble in the citrate, is by far superior in his action to superphosphate. I have likewise to remark that repeated trials have shown that phosphoric acid as precipitate is a little superior to phosphoric acid as it is in a retrograded state in the superphosphates, though both are soluble in the citrate. I attribute this difference in action to the different mechanical state of them, the precipitate permitting a finer division in the soil. The reason why monobasic phosphoric acid has in the most kinds of soils an action inferior to that one of bibasic phosphoric acid is easy to explain. In heavy

clay soils, the first one, the monobasic phosphoric acid, is put into solution by the water contained in the ground rather quickly, but is fixed immediately through the propensity of such soils to retain all kinds of salt solutions mechanically, and this in a very powerful manner. By and by it is transformed by the limestone, iron, or alumina in the ground into bibasic phosphate of lime, iron, or alumina; and as such it is by slow degrees, according to the want of the plants, again put into solution by the carbonic acid, certain salt solutions, and even by the secretion of the roots themselves. The bibasic phosphate has not to be transformed and is ready for action.

In light and sandy soils, the superphosphate is more or less lost; those soils, not having a very strong fining power, the rain washes its solution right through into the subsoil, before it has time to transform itself into bibasic phosphate. This latter, however, put into the ground as such is only—being slowly soluble—put to profit by and by, just as the plants wanted it during their growth.

The consequence of those observations has been that phosphoric acid in the precipitate of lime is already paid at a little higher rate than phosphoric acid in the superphosphate in Belgium and the north of France. The demand far exceeds the production of the former.

The enormous loss of the English superphosphate makers is not the only drawback in this important question; a great resource of the English chemical manufacturing industry is likewise cut off by maintaining the present system. In England are actually great quantities of *muratic acid* running to waste, not to count those enormous quantities which are employed for bleach making. This latter article stands at present at a price which makes it hardly worth while to manufacture it, and many works use hydrochloric acid only for that purpose, because they are not allowed to let the acid run away.

England has equally great layers of natural phosphates, too poor to be employed for superphosphate making, but they are just the thing to serve as raw material for the manufacturing of precipitated phosphate, by means of the now useless quantities of *muratic acid*. With the progress this kind of manufacture has made in the latter years, it would be an exceedingly profitable one in England.

Of course, as long as precipitated phosphate has to be exported to bring its real value, no manufacturer will find it inviting enough to go in for it, though even for export it would very well be worth while to manufacture it; and once tried in England by some farmers it would make its way in no time, even if chemists and superphosphate makers cannot as yet make up their minds to introduce officially the citrate of ammonia analysis.

May these few lines tends to direct the attention of the leading chemical men and manufacturers in England to the important questions before named, and cause them to take serious and united steps for the welfare of the English chemical trade by following a system now in application for the past four years on the Continent.

A CHEMICAL ANOMALY.

M. SCHÜTZENBERGER has recently made a communication to the Chemical Society of Paris, which if confirmed will have an important bearing upon the fundamental principles of chemical science. Whilst pursuing his researches on the petroleum of the Caucasus, the author has not been satisfied with the results of his analyses, which, though made with the greatest care, frequently showed more than 100 per cent of matter. It is known that the ultimate analysis of such bodies is effected by burning a weight, P , of the substance in pure dry oxygen, and by weighing the quantities of water and carbonic acid which alone are formed in the combustion. The weights p of hydrogen and p' of carbon are deduced from the quantities

of water and carbonic acid found, and we ought to have $p + p' = P$.

For this calculation to be correct it is not necessary that the composition of water and of carbonic acid must be absolutely exact and constant; H_2O must contain precisely 16 parts of oxygen to 2 of hydrogen, and CO_2 must consist of 32 parts of oxygen to 12 of carbon. The best analysts of all countries have demonstrated that such is the fact. In the case of M. Schützenberger's analysis the weights p and p' of hydrogen and carbon, calculated for the formulæ H_2O and CO_2 , are greater than P ; and he finds $p + p' = P + m$, without being able to find any change in the nature and purity of the products weighed.

As the Caucasian petroleum has been but recently studied, M. Schützenberger considered it necessary to verify the facts with other products. Pure aniline and benzol showed the same anomalies, yet there can be no doubt as to the composition of bodies which have been for years so completely studied; 100 parts of benzol, C_6H_6 , have given quantities of water and carbonic acid such that the sum of the weights of carbon and hydrogen present is = 101 to 101.5. All causes of error inherent in such analyses have been examined and discussed, and more than 150 experiments made.

The author has sought to prepare pure substances which should give 100 per cent, and others giving 101 per cent. In so doing he has made the curious observation that if Caucasian petroleum, aniline, and benzol are heated with sodium or copper, and distilled they acquire the property of giving more than 100 per cent on analysis, and retain it for a long time if kept in the dark. An exposure of two hours to the light was sufficient to cause a sample which had previously given 101 to 101.5, in a series of determinations, to show no more than 100 per cent. Thus sodium and copper would have the curious property of modifying certain substances without changing their apparent properties. The fact of the possibility of causing compounds to yield more than 100 per cent by the action of sodium, and restoring them to the normal state by the action of light, eliminates all errors due to weighings and manipulations: such errors would appear promiscuously in bodies whether modified by sodium or not. M. Schützenberger, without proposing any formal theory, suggests that the composition of water and of carbonic acid is not always what is supposed. It may also be that the weight of atoms varies within certain narrow limits.

If what we call an atom is merely the result of a vibratory movement of matter according to a certain law, this vibratory movement of the hydrocarbons may possibly be modified by that of sodium or by the luminous vibrations.—*Revue Scientifique* and *Les Mondes*.

RESEARCHES ON THE COMPLEX INORGANIC ACIDS.*

By WOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

(Continued from p. 31.)

PHOSPHO-MOLYBDATES.

24 : 1 *Croceo-cobalt Salt*.—The disposition of the cobalt-amines to form highly crystalline compounds, together with their well-defined and various degrees of basicity, led me to study the relations of these bases to the phosphomolybdic acids. This had already been done to a certain extent with the 5 : 1 atom series by Jörgensen, whose results I shall cite in connection with that series. Neither croceo-cobalt nor luteo-cobalt forms well-defined salts with 24 : 1 phospho-molybdic acid. I had therefore recourse to croceo-cobalt,† the oxide of which may be written— $Co_2(NH_3)_8(NO_2)_4O$, or, briefly, CcO .

* *Proceedings of the American Academy of Arts and Sciences* Communicated by the Author.

† *Proceedings of American Academy*, 10, 1.

The chloride of this series gives no precipitate with solutions of 7 : 3 ammonic molybdate, or of hydro-disodic phosphate; but in an acid solution of these two salts a solution of the chloride throws down a beautiful bright yellow highly crystalline salt, which may be washed with cold water. The portion analysed was dried on woollen paper only. Of this salt—

1.0728 grm. gave 0.8133 grm. $\text{MoO}_3 + \text{P}_2\text{O}_5 = 75.81$ per cent.

1.4520 grm. gave 0.4719 grm. $\text{P}_2\text{O}_5 = 2.96$ per cent.

This corresponds to 72.85 per cent MoO_3 by difference, and 24.19 per cent of C_2O and water by the loss. The analyses agree very closely with the formula—

$24\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot \text{C}_2\text{O} \cdot 2\text{H}_2\text{O} + 21\text{aq}$,
which requires—

		Calc.		
24MoO ₃ ..	3456	72.82		72.86
P ₂ O ₅ ..	142	2.99		2.96
CcO ..	734	15.47	24.19	24.19
23H ₂ O ..	414	8.72		
	4746	100.00		

Under the microscope this salt is seen to consist of fine yellow felted needles. It is very slightly soluble in cold water, but is soluble in rather large quantity of boiling water, giving an orange-yellow solution, with a strongly acid reaction. The solution gives with argentic nitrate a very insoluble sulphur-yellow flocky precipitate, which after a time becomes crystalline, and a pale yellow flocky precipitate with mercurous nitrate. No precipitate is formed with cupric sulphate or baric chloride. The salt could not be re-crystallised: it is interesting as a particularly well-defined soluble acid salt of the 24 : 1 atom series.

24 : 2 Acid Potassium Salt.—This salt was prepared by boiling together solutions of potassic molybdate and phosphate, adding an excess of nitric acid, and boiling the whole for some time. As in the case of the ammonium salts, the precipitation is greatly facilitated by this process taking place very slowly in the cold. The salt obtained was in very minute crystals, bright yellow, and but slightly soluble in cold water. Of this salt—

0.7772 grm. lost on ignition 0.128 grm. = 1.64 per cent water.

0.7962 grm. lost on ignition 0.0130 grm. = 1.66 per cent water.

0.1703 grm. gave 1.0895 grm. $\text{MoO}_3 + \text{P}_2\text{O}_5 = 93.10$ per cent.

1.3263 grm. gave 0.0779 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 3.76$ per cent P_2O_5 .

1.3033 grm. gave 0.0778 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 3.82$ per cent P_2O_5 .

The phosphoric oxide was twice precipitated as ammonio-magnesian phosphate. The analyses correspond with the formula—

$24\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 2\text{K}_2\text{O} \cdot \text{H}_2\text{O} + 3\text{aq}$.

which requires—

		Calc.		
24MoO ₃ ..	3456	89.55	89.31	
P ₂ O ₅ ..	142	3.69	3.76	3.82
2K ₂ O ..	189	4.90	5.25	
4H ₂ O ..	72	1.86	1.66	1.64
	3859	100.00		

Twenty-two Atom Series.—In the paper already referred to, Rammelsberg has described several salts in which he found the ratio of molybdic to phosphoric oxide as 22 : 1. Unfortunately, he has not given the method of analysis which he employed, and in a question of so much difficulty and delicacy it is, to say the least, extremely desirable to know what degree of precision may be expected in the analyses. As his results appear to be supported by my

own, I shall adopt them, leaving to the further progress of analytical chemistry the final settlement of the few doubtful points.

22 : 3 Ammonium Salt.—Rammelsberg found for the neutral salt of this series the formula—

$22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 3(\text{NH}_4)_2\text{O} + 12\text{aq}$,

which corresponds, except as regards the amount of water of crystallisation, with a phospho-tungstate which I have already described—

$22\text{WO}_3 \cdot \text{P}_2\text{O}_5 \cdot 3(\text{NH}_4)_2\text{O} + 21\text{aq}$.

In one preparation of a yellow insoluble ammonium salt exactly resembling the corresponding salt of the 24-atom series—

1.6885 grm. lost on ignition with WO_4Na_2 0.0873 grm. = 5.17 per cent NH_3 and H_2O .

1.7764 grm. gave 0.6200 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 4.17$ per cent P_2O_5 .

1.9024 grm. gave 0.6029 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 4.01$ per cent P_2O_5 .

1.2334 grm. gave 0.6262 grm. $\text{NH}_4\text{Cl} = 4.23$ per cent $(\text{NH}_4)_2\text{O}$.

The salt was dried for some time *in vacuo* over sulphuric acid, and had evidently lost water of crystallisation. If we deduct the remaining water, 0.94 per cent, and calculate the analysis for an anhydrous salt, we have for the formula—

$22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 3(\text{NH}_4)_2\text{O}$;

		Calc.		
22MoO ₃ ..	3168	91.41		91.68
P ₂ O ₅ ..	142	4.09		4.05
3(NH ₄) ₂ O ..	156	4.50		4.27
	3466	100.00		

In another preparation—

1.0324 grm. lost on ignition with WO_4Na_2 0.0922 grm. = 8.93 per cent NH_3 and H_2O .

2.0670 grms. gave 0.1255 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 3.88$ per cent P_2O_5 .

2.0352 grms. gave 0.1226 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 3.84$ per cent P_2O_5 .

These analyses lead to the formula—

$22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 3(\text{NH}_4)_2\text{O} + 9\text{aq}$,

which requires—

		Calc.		
22MoO ₃ ..	3168	87.32		87.21
P ₂ O ₅ ..	142	3.91	3.88	3.84
3(NH ₄) ₂ O ..	156	4.29	8.77	8.93
9H ₂ O ..	162	4.48		
	3628	100.00		

If, from the analyses of the two salts above describe we calculate the composition of the combination of molybdic and phosphoric oxides supposed to be isolated, and compare this with the percentages calculated upon the two hypotheses of a ratio of 22 : 1 and a ratio of 24 : 1, we have—

	Calc.	I.	II.	Calc.	
22MoO ₃	3168	95.76	95.76	96.06	3456 24MoO ₃
P ₂ O ₅	142	4.24	4.24	3.94	142 P ₂ O ₅
	3310	100.00	100.00	100.00	3598

In both cases the phosphoric acid was precipitated twice, but the ammonio-magnesian phosphate was not treated with ammonic sulphide. According to the results of Dr. Gooch, already cited, the probable error of this method does not exceed 1 per cent in excess of the quantity of phosphoric oxide present. It appears, therefore, that the correction to be applied to the phosphoric oxide in the above analyses does not at most exceed 0.04 per cent. The mean of Dr. Gooch's analyses would require a deduction of 0.02

per cent only. The yellow ammonium salt analysed by Rammelsberg corresponds to the formula —

$22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 3(\text{NH}_4)_2\text{O} + 12\text{aq}$,
which requires (Rammelsberg)—

		Calc.	
22MoO_3	.. 3168	86.04	86.45
P_2O_5	.. 142	3.86	3.90
$3(\text{NH}_4)_2\text{O}$	.. 156	4.24	3.25
$12\text{H}_2\text{O}$	.. 216	5.86	5.77
	3682	100.00	99.37

Rammelsberg gives these figures as the means of several analyses which agree well with each other, but it must be admitted that a closer correspondence with the percentages required by the formulæ would have been desirable. The comparison is not given in his paper. The air-dried salt loses all its water over sulphuric acid. The three atoms of basic water, if we assume their existence, must therefore be united by a very feeble affinity. Rammelsberg has also analysed the corresponding potassic salt of the same series. I here give his results for the sake of comparison with the formula :—

		Calc.	
22MoO_3	.. 3168	83.17	84.43
P_2O_5	.. 142	3.73	3.78
$3\text{K}_2\text{O}$	.. 283	7.43	6.86
$12\text{H}_2\text{O}$	.. 216	5.67	5.55
	3839	100.00	100.62

This salt loses all its water between 120° and 140° . In judging the results of these analyses, as well as of those which I have given, it must be carefully borne in mind that the salts themselves cannot be re-crystallised, and that consequently their absolute purity cannot be guaranteed. Moreover, if—as I believe I have shown—there are very similar salts which represent three series in which the ratios of the molybdic and phosphoric oxides are respectively as 24 : 1, 22 : 1, and 20 : 1, we may, at least occasionally, have mixtures of the salts of three or of any two series. The difficulty here is precisely that which occurs in the case of the phospho-tungstates.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, January 28th, 1882.

Dr. STONE, F.R.S., in the Chair.

New Member, Mr. W. Lant Carpenter.

Mr. T. WRIGHTSON read a paper by himself and Prof. W. CHANDLER ROBERTS, F.R.S., "*On the Fluid Density of Metals*." The results were obtained by the process described in a former paper to the Society on the fluid density of bismuth. The mean results were—For copper, 8.217; lead, 10.37; tin, 7.025; zinc, 6.48; silver, 9.51; iron (No. 4 Foundry Cleveland), 6.88. These results are slightly less than those given by Mallet's process, but they are sufficiently close. For bismuth the fluid density found by the authors is 10.055, which is slightly more than that given by Mallet's method (9.82). The authors consider their method satisfactory. It consists in suspending a ball of the solid metal from a spiral spring, and allowing it to dip into a crucible of the same metal in a molten state. The movements of the spring as the ball melts are recorded by a pencil on a band of travelling paper.

Mr. C. VERNON BOYS read a paper "*On Apparatus for Calculating Efficiency*." The object of such machines is

to automatically divide and continuously record the quotient of the speeds with which two things are turning. If the two things are the records of two of Boys's integrating machines (previously described to the Society), one finding work put into, and the other work sent out from, any combination of mechanism, then the quotient gives the efficiency of the combination. If one measures work or current and the other time or turns of a machine, the quotient measures the value of horse-power per hour or current per turn. Mr. Boys described four machines of the kind acting on two principles, from which he names them Logarithmic and Harmonic Dividers. They all derive their actions from motions of pure rolling. The simplest is made by hanging a magnetised steel reel on to a pair of iron cones which are turned by integrators. The reel travels about, and continuously shows the value of the quotient.

Mr. Boys then read a paper "*On a New Current Meter*." The rate of a pendulum clock depends on gravity, and is proportional to the square root of the strength of gravity. That of a watch depends on the strength of the hair-spring, and is proportional to the square root of its strength. The force due to an electric current is proportional to the square of the current strength. Hence if part of an electric circuit is capable of vibrating under electromagnetic force, the speed of vibration will be proportional simply to the current strength, for the square of the speed measures the force, and the force is proportional to the square of the current. If, then, such a contrivance takes the place of the balance of a pendulum clock, the clock will measure electric currents instead of time. To keep the indications true the maintaining power must be so contrived that the amplitude does not vary much, or the parts must be so arranged that the force is directly proportional to the displacement. Mr. Boys showed several ways of producing a controlling power. The first was a combination of solenoids, one passing through the other, and in which the force was proportional to the displacement. Being without iron it applies to the case of alternating currents. In another a small armature is mounted on the balance staff, and around it are the two poles of an electromagnet which forms part of the circuit. In a third form, which is unaffected by residual magnetism, two crescent-shaped pieces of iron, forming the sides of the balance, pass through two fixed solenoids. In all these cases the direction of the current does not matter.

The maintaining power may be an ordinary escapement driven in the usual way. It may also be independent of clockwork, an impulse being given to the balance electrically at each swing. A meter of this kind was shown, in which the controlling power depends on iron crescents and solenoids, and in which a portion of the main current is shunted through secondary solenoids when the balance is in its neutral position, at which time a variation in the currents in the controlling solenoids has no effect in disturbing the period of oscillation. Such a meter is regulated by an adjustable weight if it goes too fast or slow. Being independent of gravity it will work equally well anywhere.

Prof. JOHN PERRY thought Mr. Boys's devices very promising, and mentioned that Professor Ayrton and he had invented a very simple current meter not yet described.

Dr. COFFIN pointed out that electric clocks of a certain class were really current meters.

Prof. GUTHRIE remarked that in Mr. Boys's meter practically no work was taken from the current.

Reference was made by Dr. Stone and Mr. Lecky to Hipp's clocks, the latter testifying to their efficiency.

Captain ABNEY, R.E., then exhibited some experiments on the Phenomenon of Phosphorescence. Balmain's luminous paint, calcium sulphide, and other substances give out a violet light after having been excited by daylight. Captain Abney found that when the spectrum was allowed to fall on an excited surface of Balmain's paint the blue rays enhanced this violet light and the red end of the spectrum extinguished it. This was shown to the

meeting, and the red end of the spectrum appeared on the paint in well-defined black bands. Similarly, the light from an electric lamp passed through a sheet of red glass extinguished the phosphorescence. Captain Abney's researches further show that there is a series of octaves in the blue end of the spectrum which refuse to quench the violet light. He found the mean wave-length of the rays exciting the phosphorescence to be 4300.

Prof. Guthrie also showed that calcium sulphide tubes glow in violet light.

PHILOSOPHICAL SOCIETY OF GLASGOW.
CHEMICAL SECTION.

January 9, 1882.

MR. ROBERT R. TATLOCK, President, in the Chair.

THE minutes of the last meeting were read and confirmed.

Mr. MACTEAR read a short paper on "*Fossilisation of Wood*." He pointed out how easily wood, subjected to the action of water containing lime and silica and then to that containing acid, might be fossilised, and showed some specimens of "bog wood" which he had partially fossilised by that means.

Mr. WHITELAW having taken the chair,

Mr. TATLOCK read a "*Note on the Valuation of Crude Saltpetre*."

The object of this note is to point out the fallacious character of the analyses of crude saltpetre made by what is known as the "refraction" method, which, unfortunately, is still employed by some chemists. According to this process all the chloride of potassium present is rendered, but of course erroneously so, as chloride of sodium, and, as the amount of saltpetre is arrived at by difference, it must necessarily be in error to the extent of the difference between the combining weights of potassium and sodium calculated upon the proportion of potassium actually present in the form of chloride, and which is sometimes sufficiently large to affect very materially the value of the article as represented by the so-called "refraction." It will be apparent from this that in all cases a potassium determination is necessary, as otherwise the chemist is not in a position to state the true proportion of pure nitrate of potash in the sample examined; and unless this is done he is not, in my opinion, entitled to certify to the presence of a given amount, or to state the "refraction," which is obviously the same thing.

The following example of an "analysis" of saltpetre, as compared with a "refraction," will sufficiently serve to illustrate this:—

	"Analysis" per cent.	"Refraction" per cent.
Nitrate of potash	76.33	78.91
Sulphate of potash	0.96	0.96
Chloride of potassium	11.96	—
Chloride of sodium	6.65	16.03
Sulphate of lime	0.26	0.26
Chloride of magnesium	0.27	0.27
Insoluble	0.27	0.27
Water	3.30	3.30
	100.00	100.00
Refraction	23.67 (Real.)	21.09 (Apparent.)

There is thus, in this sample, an obvious error of 2.58 per cent by the refraction method, in favour of the saltpetre; and as it sometimes happens that nitrate of soda is present in considerable quantity, a further error in the same direction may occur if a potassium determination is not made, and the nitrate of potash taken merely by difference.

Mr. TATLOCK also gave a "*Note on Fireproofing of Cotton and other Fabrics*."

A vote of thanks was proposed both to Mr. Mactear and Mr. Tatlock.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, December 24, 1881.

Mr. J. W. SWAN, President, in the chair.

THE PRESIDENT—Before commencing the business of the meeting, I must mention a fact which it gives me great pain to have to communicate, I mean the death of Mr. Robert Calvert Clapham, the news of which has only just reached us. I am sure that only one feeling will exist amongst you, one of deep regret at the loss which we have sustained. I think it will probably be agreeable to your feelings that some official notice should be taken of this sad event. I will, therefore, move that a resolution in reference to it be drawn up and entered on our minutes, and that, after a decent lapse of time, it be communicated to his widow.

Mr. SCHOLEFIELD—I beg to second that motion, and, as the news has come so recently and unexpectedly, I think the wording of the resolution might be left to the President and Secretaries.

Mr. JOHN PATTINSON—I cannot help expressing my regret at hearing of Mr. Clapham's death. It is perhaps not known to all the members present that Mr. Clapham took a very active part in the formation of this Society, and has perhaps more right than anyone else to be considered as its founder.

The motion was carried unanimously.

Mr. SWAN read the following paper on "*Voltaic Accumulation*." We owe the term voltaic accumulation to M. Planté; we owe the idea of voltaic accumulation to him also. But more than this, we owe to Planté the rich results of a life devoted almost entirely to researches in connection with this subject. M. Planté employs the phrase voltaic accumulation in a double sense—to signify storage, and to signify cumulative effect. It is in this last sense that the term is generally used by M. Planté, and it is to voltaic accumulation in this sense that M. Planté has chiefly directed his attention. One of his principal aims has been to produce by means of voltaic accumulation the high tension effects usually obtained from the frictional electrical machine. At no very distant period the phenomena of voltaic electricity and of frictional electricity were so widely different, that a strong effort of the imagination and a clear perception of the laws governing these phenomena was necessary, in order to be able to entertain the belief that the agency which, led by naked wires, operated so quietly in causing the deposition of copper in large quantity from copper solution, could be the same which, bursting all bounds, rushed with flash and detonation to its goal.

When the platinum terminals of a voltaic battery composed of a few cells are made to dip in acid water, gas in torrents pours upward from them. If the same platinum poles, dipping in the same acid solution, be disconnected from the quietly but powerfully working battery, and put in connection with the prime conductor and the cushion of a large electrical machine of the frictional type, you may turn the handle by the hour and produce an amount of electricity that would maintain a continuous stream of fire, and yet not a single bubble of gas will rise from the platinum poles. Moreover, the voltaic cells which decomposed the water so rapidly would give no shock, nor the tiniest spark through the smallest measurable space of air; while the chemically ineffective electrical machine would rack your limbs terribly and dart its spark through several inches of hair.

At a very early period of the history of the voltaic battery it was known that by largely multiplying the

series of cells, both sparks and shocks could be obtained from the terminal conductors; and on the other hand it was found that, by employing electrical machines of great power and forming poles of fine platinum wire coated with glass to the end, so as to reduce to almost a point the exposed surface of the platinum, water could be slowly decomposed.

In later years the two classes of phenomena characteristic of the voltaic battery and the electrical machine have made considerable advances towards each other. De la Rue has constructed a battery of 30,000 of his zinc and silver couple capable of producing a discharge through one-third of an inch of air; capable also of illuminating long vacuum tubes and of producing other effects of high electric tension. At the Paris electrical exhibition I saw an electrical machine on the Holtz principle, composed of 30 glass plates of small diameter, which was capable of decomposing water freely and of maintaining a thin platinum wire white hot as long as the plates were kept revolving. These approaches to identify of effect, by the electricity of voltaic action, of friction, and of induction, are of recent date. Before these results had been obtained, M. Planté, by means of methods the most ingenious and experiments the most striking, completely bridged the gulf that separates the phenomena of high tension and low tension electricity. M. Planté has achieved this result by means of secondary voltaic action.

The charging and re-charging of a series of 30,000 cells must evidently be an extremely troublesome operation. M. Planté avoids this trouble by making a few cells (two are sufficient) do the work of charging any number of secondary cells, which, after being charged, are joined in series, and made to develop high tension effects. This is chiefly the kind of accumulation performed by M. Planté by means of his secondary cell, namely, the accumulation of tension or electro-motive force. Here is a Planté cell. It consists of two plates of lead rolled together but separated by narrow strips of gutta-percha. These two lead plates being, to begin with, in the same condition, generate no current when immersed in dilute acid and united through the wire of a galvanometer. But if the couple be for a time connected, the one plate with the anode and the other with the cathode of a voltaic cell or any other form of electrical generator capable of developing an electro-motive force of not less than 3 volts, the anode plate becomes coated with peroxide of lead. If then the secondary cell be detached from the primary cells it will be found to be capable of generating a powerful current of about one-fifth more electro-motive force than Grove's cell. When it is desired to obtain cumulative effects from a series of Planté's cells, a mechanical arrangement is made whereby the plates of the different cells are so connected together that they are in effect one couple; that is to say, all the inner plates are connected together as one plate, and all the outer plates are connected together as one plate. Arranged in this manner, if one of the poles of two Grove cells coupled in series be connected with the terminal which is common to all the inner plates, and the other pole be connected to the terminal common to all the outer plates, the same change takes place in the 100 or it may be the 1000 cells as that which takes place in charging a single cell. That is to say:—if all the outer plates were connected with the positive pole of the Grove's cell, all these plates would be oxidised, and in this condition all the cells may be said to be charged just as a Grove cell is charged when one puts the nitric acid into it; for the highly oxidised lead of a Planté cell plays exactly the same part as the nitric acid of a Grove cell, and it is only necessary to alter the connection of one cell with another, so as to connect them in series, in order to obtain from them the cumulative electro-motive effect due to their number. Planté has devised a convenient method of making this change in the connections. This apparatus illustrates the arrangement.

The cells are arranged in line with a spring projecting

upwards from each plate on each side of the line; between these two lines of springs an axle of ebonite runs, with metal bands so inlaid upon it, that when it is in one position all the springs on one side are pressing against a long strip of copper on that side, and all the other springs on a corresponding long strip of copper on the other side. In this position the cells are arranged for charging, the two long strips of copper being the two poles. When charging has been effected it suffices to turn the ebonite bar on its axis through a quarter of a circle in order to disconnect the springs from the two long strips of metal mentioned, and to bring them into contact with short strips of copper inlaid and insulated in the bar and crossing it obliquely so as to put the oxidised or positive plate of one cell in metallic communication with the non-oxidised plate of the next cell throughout the entire series. The change of connections is the work of a moment and the result is a multiplication of the electro-motive force by the number of the cells.

I saw at M. Planté's house, which is also his laboratory, 800 cells arranged in this way, all charged from two Bunsen cells, which were placed outside the room on the window sill. By means of these 800 cells, worked in this convenient manner without the slightest annoyance from fumes or acids, the effects of about 900 Grove cells were obtained.

[Mr. Swan here illustrated the working of the apparatus by means of a battery of 20 small Faure cells arranged in a Planté commutating trough. When connected parallel, a copper wire was heated to whiteness and melted, and when in series, a Swan lamp was brilliantly illuminated.]

M. Planté went a step beyond this. He charged a large series of plates of mica, partly coated on each side with tin-foil, on the principle of the Leyden jar. These were connected in charging and in discharging in the same manner as the secondary battery, that is all the coatings of tin-foil turned one way were connected together, and all the coatings turned the other way were connected together. When, by the momentary joining of these two groups of plate coatings to the two poles of 800 secondary cells, the plates became charged, the connections were then changed from quantity to tension. By this contrivance the electro-motive force of the 4 volts, due to the two primary Grove cells, was accumulated first to 1800 volts and this again was increased fifty-fold by the mica plates. I can bear witness to the fact that it was sufficient to produce flashing discharges some inches in length, exactly resembling the discharges of a frictional electrical machine.

That is electrical accumulation in one sense, but there is another sense in which the phrase has been much used of late in connection with Faure's accumulator, namely, in the sense of storage. Planté's cell, with slight modifications, lends itself most perfectly to voltaic accumulation in the sense of storage. The very essence of the idea of storage is retentivity. The cell, to act as a reservoir or store, must be retentive of the charge communicated to it. This is a quality possessed in an eminent degree by the Planté cell. There is, comparatively with other voltaic cells which, but for the want of retentivity, might be employed for electrical storage, very little loss of charge by lapse of time with in the limit of a few hours. But for the defect of loss of charge by local action—that is, chemical action not utilisable in the production of electric current, the zinc and copper cell of Daniell and several other well-known voltaic combinations not usually regarded as susceptible of being used as secondary cells might have been employed for electrical storage.

Perhaps the ideal of a cell for storage is Grove's gas cell. Here is a specimen of it; it consists of two gas tubes, and two plates of platinised platinum immersed in dilute sulphuric acid. If, while the tubes are filled with dilute acid, one plate is connected with the positive and the other with the negative pole of a voltaic battery, the one tube becomes filled with oxygen and the other with hydrogen, and when so filled the cell is an electric store

capable, even after the lapse of a long time, of yielding a current.

But Grove's cell is quite out of the question for large operations, if only because platinum is so scarce. Theoretically it would perhaps be improved by making the hydrogen pole of palladium instead of platinum, so as to obtain the advantage of greater condensation of the hydrogen and thus to reduce the resistance by increasing the extent of the contact between the gases, the pole-plates, and the acidified water. Dr. C. W. Siemens communicated to the York Meeting of the British Association some interesting experiments in the employment of plates of carbon, both simple and platinised, as substitutes for platinum plates in the construction of a gas battery. The porosity of the carbon plates was utilised so as to bring the poles close together and greatly reduce resistance. The results obtained were well worthy of publication, although they did not quite reach the point aimed at, namely, practical utility for the electrical storage of energy.

I had imagined that De la Rue's cell, composed of zinc and silver incrustated with chloride of silver, might probably be employed in certain exceptional cases for electrical storage. On mentioning this very obvious idea to Dr. De la Rue, he told me there was a difficulty in the way, arising out of the tendency to the formation of oxychloride instead of chloride of silver.

For electrical storage on any large scale we look in vain to discover a better material than that fixed upon after infinite painstaking by M. Planté. Planté cell, pure and simple, is a most admirable electrical accumulator in the storage sense of the word. It has one drawback, however, it requires a considerable time to give to the lead plates a large storage capacity. M. Planté's method of preparing his cell is as follows:—

"The secondary cell is first filled with water acidulated with sulphuric acid (1 quart acid to 10 quarts of water), and on the first day it is charged by the current from two Bunsen cells six or eight times, the direction of the primary current being changed at each new charge. The secondary cell is discharged between each reversal of the direction, and it is ascertained either by heating a piece of platinum wire to incandescence, or by other suitable means, that the duration of the secondary current continually increases after each charge.

"The time during which the secondary couple is submitted to the action of the primary current in the same direction is increased little by little.

"Thus, on the first day, the period is increased from a quarter of an hour to half an hour and one hour, and, finally, the battery is left over-night in the process of charging. The next day it is discharged and then re-charged for two hours in the opposite direction, then again in the previous one, and so on. But soon a limit is reached, beyond which the duration of the secondary current is not found sensibly to increase, especially when the primary cells, not having been removed, have grown by these successive actions little by little weaker, and have no longer sufficient intensity to cause the electrolysis to penetrate deeper into the interior of the lead plates.

"The secondary couple is then left at rest for eight days, and at the end of that time is re-charged in the opposite direction for several hours continuously, without making on that day a fresh alteration in the direction of the primary current,

"Then the interval of rest is extended little by little to a fortnight, one month, two months, &c., and the duration of the discharge is found to go on continually increasing. It has, in fact, no other limit than the thickness of the lead plates. The positive plate, if it is thin, finishes by being almost entirely transformed by time into peroxide of lead of a crystalline texture; and the negative plate becomes formed by degrees, to a certain depth below its surface, of reduced lead of a granular and crystalline nature.

"It is not always necessary to push the electro-chemical

preparations of secondary couples as far as this complete transformation of the physical and chemical nature of the plates, for the couples would ultimately acquire a much greater resistance and take more time to charge them.

"When the couples yield a current of sufficient duration for the purposes for which one wants them, it is no longer necessary to change the direction of the primary current each time the cells are charged. The quantity of peroxide of lead accumulated upon the positive plate would take too long to reduce, and no result would be got from the couple before several hours. A definite direction is therefore adopted, in which the secondary cells, when once sufficiently 'formed,' are always charged."

It is evidently desirable—more especially in view of the want more and more urgently felt as time goes on, of an accumulator which will be available for the large and important uses to which electricity will in future time be put—if possible, to avoid this tedious process of preparation so minutely described by M. Planté. No doubt it answers the purpose quite well when industrial applications are not in the question, but for electrical accumulators such as must be used in connection with a central system of electric lighting, and which would probably involve the use of a set of large cells in every house, this slow process of preparation would be hardly applicable. It was with a desire to avoid this disadvantage and give to Planté's cells a greater capacity of storage, that I made the experiments last winter, the outcome of which was the modification of Planté's cell, which I showed you at our February meeting. Here are some of the cells I then exhibited in action. The idea of this modification was to increase the surface of the lead by means of lead foil, crimped and formed into frills, the interstices between the frillings being filled with electrolytically deposited spongy lead. The same idea has been applied in a somewhat different way by M. Faure in his accumulator. In M. Faure's accumulator red-lead, mixed with dilute sulphuric acid, is plastered on lead plates; the coated plates are wrapped in felt and either rolled up like the plates of a Planté's cell or doubled together, and placed in rectangular lead-lined wooden boxes. These cells have been made on a large scale, and for this reason, and because the application of the red-lead coating greatly favours the obtaining of storage capacity, effects have been obtained from them clearly pointing to practical use in electric lighting, and perhaps also for other purposes. The cell has, of course, the same electromotive force as the Planté cell, of which it is a modification; being large, it has, when fully charged, a small resistance, and is, on that account, capable of producing astonishing effects in the way of heating thick wire. [Heats some wire.] 30 of these cells, weighing about 50 lbs. each, when properly charged will keep 20 of my lamps up to 20 candle-power for several hours.

M. de Meritens has also made an accumulator on the Planté lines. The Meritens accumulator consists simply of plates built up of lead-foil. Here is a representation of one of his plates shown in section. I have not any accurate information of the working of De Meritens's cell.

I have recently introduced into the construction of the Planté cell some modifications which, I anticipate, will increase its utility when applied on a large scale for the practical work of storage for electric lighting. One of my innovations consists in making the lead plates corrugated or cellular, the cells or grooves being filled with spongy lead, which from the form of the plate will remain attached to it without any external wrapping of felt or similar material being necessary. The felt in the Faure cell must, I imagine, be in a short space of time destroyed by the action of the acid, and occasion displacement of the material applied to the surface of the plate and held in its position by it. I have heard that it is proposed to substitute asbestos cloth for the felt—this no doubt will remedy the defect I have mentioned, but it must greatly increase the cost of constructing the cell. It is obviously

desirable to avoid the use of any extraneous material, and the use of grooves or cellular plates accomplishes this object. I have made other improvements for the means of obtaining electrical storage; details of which I must, for the present, hold in reserve, but with the hope at some future time of bringing them under the notice of the Society.

A hearty vote of thanks to Mr. Swan for his interesting paper and illustrations concluded the proceedings.

NOTICES OF BOOKS.

The Retrospect of Medicine. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M.D. Vol. lxxxiv., July to December, 1881. London: Simpkin, Marshall, and Co.

IN this volume several articles relate to the germ theory of disease and the pathological action of microbia in the animal economy. Dr. Harley's important researches on the effects of animal and vegetable ferments introduced into the system are a step towards the solution of certain weighty questions. But they could never have been undertaken without certain operations which in these days are shrieked at as "vivisection." We do not find that the author, though he experimented with the venoms of the cobra and the puff-adder, comes to any conclusion as to the nature of these agents. In classifying the germs which produce human diseases, he draws a distinction between Brownian granules and micrococci, vibriones, and bacteria. He states that in each of three diseases—glanders, syphilis, and rabies—an entirely distinct organism is developed in the saliva. The thrush in the mouths of children, the potato blight, and the vine disease, as well as the epidemics among salmon and silkworms, are all, it is suggested, due to one kind of fungus, *Botrytis basiana*.

Much additional light has been thrown on the "wool-sorters' disease." It is not confined to Bradford, but has proved fatal at Leicester, Norwich, Glasgow, Constantinople, and in Massachusetts, and it is suspected at the Cape, in Peru, and Asia Minor. It attacks packers, washers, carders, overlookers, and buyers, as well as sorters. Alpaca and mohair are not the only infective materials, as British wools—and, indeed, all hairs and wools except the Algerian—may contain uncleaned fleeces from animals which have died from anthrax. The danger to the workmen is found to be greatly lessened by washing the wools in warm water and sorting them whilst still damp. By this precaution the risk of inhaling the dust of morbid matter is greatly reduced.

Year-Book of Pharmacy: comprising Abstracts of Papers relating to Pharmacy, Materia Medica, and Chemistry, contributed to British and Foreign Journals from July 1, 1880, to June 30, 1881, with the Transactions of the British Pharmaceutical Conference at the Eighteenth Annual Meeting, held at York, August, 1881. London: J. and A. Churchill.

MUCH of the matter in this volume, extracted from the scientific journals at home and abroad, cannot of course lay claim to novelty. The ptomaine question is naturally treated at some length. The poison detected in sausages by Sonnenschein and Zuelzer, and the morbid matter shown to be present in decomposing maize and in certain samples of cheese, seem to belong here. The ptomaines are considered as including all alkaloidal products of decay, whether formed in the presence or the absence of air. The untrustworthiness of the ferricyanide test is insisted on, in quotations from A. Gautier and C. Tanret.

Fool's parsley (*Aethusa cynapium*), after being traditionally denounced as a poison, has been experimentally proved to be harmless. Mikania guaco is represented, on

the authority of Mr. R. B. White, of New Granada, as a cure for the bites of the most venomous snakes of South America. The use of saffron as a condiment, which still survives in Cornwall, is traced back to the Phœnicians. It appears to us that the classification of the subjects as chemical or pharmaceutical is carried out more consistently in the present volume than was the case in former years.

Among the papers read before the Pharmaceutical Conference a prominent place belongs to that by Mr. C. Ekin, F.C.S., on the tests for nitrites in potable waters. He stated that the meta-phenylen-diamin test gives a distinct reaction with 1 part of nitrogen present in the form of nitrous acid in one million parts of water. The naphthyl-amin test detects with ease one part in one-hundred millions, and with care even as little as one part in a thousand millions. The author shows, however, that the "old-fashioned potassium iodide and starch test" is, to say the least, equally delicate. If the solution is allowed to stand for some days (in a stoppered bottle) even smaller proportions than one part in a thousand millions are indicated. The author complains, as omissions, that the Rivers' Pollution Commission made no separate determination of nitrates as distinct from nitrites, whilst the Society of Public Analysts, in their recent circular on Water Analysis, omit the subject entirely. This is the more to be regretted, as the nitrites, if present in a water, are evidence of recent sewage in the very act of decomposition.

Catalogue of Dr. Schuchardt's Chemical Works, Görlitz.

DR. SCHUCHARDT stands, we believe, absolutely unrivalled in the speciality which he has taken up. At his establishment chemical preparations may be obtained, not merely of the highest possible purity, but in large, regular, and beautiful crystals. Hence they are admirably adapted for optical, crystallographic, and thermo-chemical researches, and for preservation in museums as characteristic specimens. The preparations are arranged according to their crystalline systems. A peculiarity of the catalogue is that the various bodies have received the Latin pharmaceutical names instead of those used in pure chemistry and in manufactures. Thus "Natrium chloratum" means not, as might be naturally supposed, sodium chlorate, but sodium chloride. We do not see what is gained by this exceptional nomenclature, which but for the formulae accompanying would be perplexing. Dr. Schuchardt's beautiful collections of crystallised chemicals have been much admired at various exhibitions.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 1, January 2, 1882.

Diffusion of Solids.—A. Colson.—If discs of iron, already partially carburated, are heated along with fresh discs, both absorb the same quantity of carbon if the diffusion of carbon in the metal is proportional to the duration of the heating. To a given temperature there corresponds a constant coefficient of diffusion of carbon in the iron. This law is only true when the iron is converted into steel; when cast-iron begins to be formed, that is, a little before the iron becomes brittle, the absorption of carbon decreases. Silica ranks among the bodies most easily diffusible in carbon. By heating platinum in lamp-black containing 60 per cent of precipitated silica, we obtain a crystalline body, Si_2Pt_3 , of the specific gravity 14.1,

and melting at about the same temperature as common glass.

Diffusion of Carbon.—J. Violle.—The author refers to a fact which he observed and described in the *Comptes Rendus* (lxxxvii., p. 981), i.e., the diffusion of carbon in porcelain. This phenomenon may be observed if a porcelain crucible is placed within one of graphite and heated to 1000° to 1500°.

Determination of the Ohm: a Reply to M. Brillouin.—M. Lippmann.—The object being the determination of the ohm as exactly as possible, it is sufficient to reach it by the use of coils of ordinary dimensions. It appears superfluous to insist upon giving impracticable dimensions to these instruments in order to find the author's method defective.

Measurement of Potentials Corresponding to given Explosive Distances.—J. B. Baille.—The potential of an electrified plane increases about regularly with the explosive distance to be traversed. The electric densities may be calculated corresponding to these different spark-lengths; it will be seen that these densities decrease at first slowly, and soon arrive at a constant value, about 0.5 c.m. The pressure exerted by electricity upon the air at the moment when the spark is about to spring 0.01 metre is only 1-2000th of the atmospheric pressure.

Proportion of Potassa to Soda in Natural Waters.—C. Cloëz.—Except in especial cases the potassa contained in waters is at the most one-fifth of the sum of the alkalies, and if it is derived from the decomposition of felspar rock, another origin must be sought for the soda. As the chlorine present is in the majority of cases proportional to the sodium, it follows that all soils, with the possible exception of the granitic, are impregnated with sea-salt, whilst the argillaceous soils alone contain potassium salts.

Complex Function of Morphine and its Transformation into Picric Acid: its Solubility.—M. Chastaing.—The author mentions certain reactions which confirm the phenolic function of morphine. Tetrahydrated nitric acid at 100° converts morphine into an acid, $C_{20}H_9NO_{18}$, which, if heated in a sealed tube to 100° with monohydrated nitric acid, is converted into picric acid. Hence morphine contains an aromatic nucleus. One litre of water at 0° dissolves traces of morphia; at 10°, 0.10 grm.; at 20°, 0.20 grm., &c., but above 45° the solubility of morphia increases more rapidly.

Artificial Production of the Forms of Organic Elements.—D. Monnier and C. Vogt.—Figured elements presenting all the characters of form belonging to the organic elements, such as cellulose, either simple or with porous canals, tubes with sides, with septa, and with heterogeneous granular contents, can be artificially produced in an appropriate liquid by the joint action of two salts, forming by double decomposition, either two insoluble salts, or a single one. One of the original salts must be present in solution, whilst the other is added in a solid form. [In February, 1878, M. G. Fournier, of Paris, performed experiments giving substantially similar results in presence of the Editor and a friend.]

Zeitschrift für Analytische Chemie.
Vol. xx., Part 3.

Spectroscopic Researches.—C. L. Ciamician.—Already noticed.

The Spectrum of Glucinum.—C. L. Ciamician.—This spectrum is perfectly homologous with those of carbon, boron, and magnesium.

Separation of Copper and Cadmium.—G. Vortmann.—The dilute solution (sulphuric or hydrochloric) of the metals is mixed with sodium hyposulphite till completely decolourised, and is then heated to a boil, when the copper is separated as a heavy black sulphide. The boil-

ing is continued till the liquid has become clear. After filtration and careful washing the copper sulphide is mixed in the known manner with sulphur, and heated in a current of hydrogen. The cadmium in the filtrate is precipitated by one of the known methods.

Detection of small Quantities of Morphia.—A. Jorissen.—The solution of morphia, free from foreign bodies, is evaporated to dryness, and the residue is heated on the water-bath with a few drops of sulphuric acid. A minute crystal of ferrous sulphate is then added, bruised with a glass rod, stirred up in the liquid, heated for a minute longer, and poured into a white porcelain capsule, containing 2 to 3 c.c. strong ammonia. The morphia solution sinks to the bottom, and where the liquids touch there is formed a red colour, passing into violet at the margin, whilst the ammoniacal stratum takes a pure blue. The reaction is very distinct to 0.0006 grm. Codeine does not give this reaction. If sulphuric acid at 190° to 200° is allowed to act upon morphia, there is ultimately formed an opaque black-green mass. If this is poured dropwise into much water, the mixture turns bluish, and if it is then shaken up with ether or chloroform, the former takes a purple and the latter a very permanent blue. Codeine gives the same reaction, but no other of the alkaloids. This reaction can be obtained very distinctly with 0.0004 grm. of morphia.

Journal de Pharmacie et de Chimie.
September, 1881.

Action of Arsenic and Phosphoric Acids upon the Sodium Tungstates, and a New Method for the Analysis of the Tungstates.—Jules Lefort.—For determining the tungstic acid of a soluble tungstate it is sufficient to acidify slightly with acetic acid, and to add quinine acetate or sulphate in slight excess dissolved in distilled water. There is produced an abundant white precipitate, which shrinks on standing, and is washed with cold water. The deposit is collected on a filter, dried in the stove, and is then heated to redness in a platinum crucible. By the successive addition of a few drops of nitric acid all the quinine is destroyed, and tungstic acid alone remains, and is weighed. This method is perfectly exact.

Anæsthetics.—Alfred Riche.—A medical paper.

Phytolacca Dioica.—M. Balland.—The author has not succeeded in discovering the presence of an alkaloid.

Quinoidine Borate.—M. de Vrij.—The author examines the value of this compound as a febrifuge.

Poisonous Matters Produced by Man and the Higher Animals.—Armand Gautier.—The author has extracted from normal urine, from the poison of the cobra, and from human saliva, poisons closely resembling the *ptomaines*, forming crystalline chloraurates, and chloroplatinates, and having the power of rapidly reducing potassium ferricyanide.

Poisonous Action of Potassium Chlorate.—M. Ludwig.—Potassium chlorate is completely reduced in the human organism to potassium chloride. Its action is similar to that of arsenic and phosphorus.

October, 1881.

Anæsthetics.—A. Riche.—An illustrated paper continued from the September number.

Action of Arsenic and Phosphoric Acids upon the Sodium Tungstates, and a New Method of Analysing the Tungstates (Continued from the last number).—Jules Lefort.—The author distinguishes the yellow metatungstic acid from the colourless variety, and proposes to give it the name of meta-luteo-tungstic acid.

Formula of Pilocarpine.—P. Chastaing.—According to the author the formula of pilocarpine is $C_{22}H_{16}N_2O_4$. The formula of Mr. Kingzett would require 32.85 per cent of carbon.

Certain Oxidation-Products of Morphine.—P. Chastaing.—By the action of gaseous hydrochloric acid upon the alcoholic solution of morphine, the author has obtained a hydrated oxy-morphine. By the acid of nitric acid upon morphine he has obtained a series of acid products, the nature and relations of which require further study.

Determination of Tannic Acid.—M. Lehmann.—The author takes a quantity of the sample supposed to contain from 2 to 6 decigrammes of tannic acid. It is exhausted with boiling water, and the liquid is concentrated down to 100 or 200 c.c. of filtrate. To 20 c.c. of this solution are added 20 c.c. of a saturated solution of ammonium chloride. There is then run into the mixture by means of a burette graduated in tenths of c.c. a solution containing 1 grm. gelatin in 100 c.c. of a saturated solution of ammonium chloride. The presence of this salt renders the separation of the precipitate both rapid and very distinct. The flow of the solution of gelatin is stopped as soon as a precipitate no longer forms. To find the exact moment when the tannin is entirely precipitated a small quantity of the liquid is filtered, and the filtrate is tested upon a watch-glass with solution of gelatin and with the solution of the sample. It should give no precipitate with either. The gelatin solution is standardised previously with a solution of pure tannin.

Novel Reactions of Milk.—C. Arnold.—If a little tincture of guaiacum is added to fresh milk a blue colour is produced. Milk heated to 80° or upwards remains uncoloured. Sour milk takes the same tint, but the reaction is prevented by the addition of mineral acids and alkalies. If a little starch-paste mixed with potassium iodide is added to milk which has been mixed with old oil of turpentine, a fine blue band appears at the surface of contact and spreads rapidly. Milk freed from albuminous matter does not give this reaction. If to fresh milk there is added first acetic acid to precipitate the caseine, then some caustic potassa, and lastly a trace of a solution of copper sulphate, the violet reaction characteristic of peptone does not appear, but if the milk is allowed to stand fifteen to twenty hours before this treatment, the violet colour is obtained. The author considers the blue colour due to ozone.

Die Chemische Industrie.
Vol. 4, No. 10.

This issue is taken up with the report of the meeting of the German Association of Chemical Manufacturers, held Sept. 17th, at Reichenhall; an important report presented by Dr. G. Lunge to the Congress of German Alkali Manufacturers, Sept. 15th; and the list of chemical patents.

Vol. 4, No. 11.

This number contains the conclusion of Dr. Lunge's report to the Association of German Alkali Makers.

Vol. 4, No. 12.

Determination of Small Quantities of Arsenic in Sulphur.—H. Schæppi.—10 grms. of sulphur, pulverised as finely as possible, are covered with hot water and a few drops of nitric acid, digested for some time, filtered, and washed till the washings have no longer an acid reaction. Thus calcium chloride and sulphate are removed, and calcium sulphide if present is destroyed. The sulphur thus prepared is covered with water at 70° to 80°, a few drops of ammonia are added, and the mixture is digested for a quarter of an hour. All the arsenic present as sulphide is dissolved, and the ammoniacal liquid is variously treated according to the degree of accuracy required. For perfectly accurate determinations the ammoniacal solution is mixed with silver nitrate, and all the sulphur present in the state of arsenic sulphide is thrown down as silver sulphide, acidified with nitric acid, filtered, and washed. The precipitate of silver sulphide is dissolved in hot nitric acid and determined as silver chloride. From the weight

of the latter the arsenic sulphide is calculated. As a less accurate but more rapid method the ammoniacal solution of arsenic sulphide is cautiously neutralised with pure dilute nitric acid and considerably diluted. It is then titrated with decinormal silver nitrate till a drop of the solution is turned brown with neutral chromate. The arsenic is easily calculated from the quantity of silver nitrate consumed. For very rough determinations it is sufficient to treat 10 grms. of finely-ground sulphur with nitric acid, to extract with ammonia, and to add silver nitrate. From the intensity of the colour, or the quantity of the precipitate of silver sulphide, it may be judged if the sulphur is approximately free from arsenic or strongly contaminated. The author states that contrary to the general belief, reddish-yellow sulphur is more free from arsenic than such as is of a full yellow colour.

Bulletin de la Société Chimique de Paris.
Tome 36, Nos. 8 and 9.

Certain Derivatives of the Dichlorinated Naphthalines δ and ϵ .—J. E. Alen.—The author examines the oxidation of dichloro-naphthalines δ and ϵ , as effected by nitric acid at different strengths.

Archives Néerlandaises des Sciences Exactes et Naturelles.
Tome xvi., Livraison 4.

The Influence of the Moon on the Movement of the Magnetic Needle.—S. P. Van der Stok.—A mathematical discussion of observations.

Crystallisation of the Diamond.—H. Behrens.—The author rejects the supposition that the diamond is formed by successive layers.

MEETINGS FOR THE WEEK.

- MONDAY, 6th.—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.
— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 7th.—Institute of Civil Engineers, 8.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick
— Pathological, 8.30.
— Society of Arts, 8. "Notes on the Trade Capabilities of Newfoundland," by E. Hepple Hall.
WEDNESDAY, 8th.—Society of Arts, 8. "The Manufacture of Ordnance," by Colonel Maitland.
— Geological, 8.
— Microscopical, 8.
THURSDAY, 9th.—Royal, 4.30.
— London Institution, 7.
— Royal Institution, 3. "Corals," by Prof. H. N. Moseley.
FRIDAY, 10th.—Royal Institution, 8. "The Climate of Town and Country," by Professor Frankland, 9.
— Quekett Microscopical Club, 8.
— Astronomical, 8. (Anniversary.)
SATURDAY, 11th.—Royal Institution, 3. "Ludwig van Beethoven," by Prof. Pauer.
— Physical, 3. Annual General Meeting. "On the Relations between the Electromotive Force of a Daniell's Cell and the Chemical Affinities Involved in its Action," by Dr. C. R. Alder Wright.

NOTES AND QUERIES.

*. Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Combination of Acids and Bases.—I should be glad to hear where I could see an account of how the acids and bases are combined together in a compound. In making an analysis of a mineral water what bases and acids are generally put together in drawing up the report.—A.D.

TO CORRESPONDENTS.

J.K.—The subject is a purely medical one and not within our province.

THE CHEMICAL NEWS

VOL. XLV. No. 1155

THE ANALYSIS OF POTABLE WATER,
WITH SPECIAL REFERENCE TO THE
DETERMINATION OF PREVIOUS SEWAGE
CONTAMINATION.*

By CHARLES W. FOLKARD.

In the first place, the author reviewed the present state of analytical chemistry, the conclusion being that, as far as mineral substances were concerned, the existing methods were nearly perfect. But when organic analysis was considered, a different state of things was apparent, owing to the great number, complexity of structure, and unstable nature of many organic bodies, especially those contained in the secretions and tissues of plants and animals; in addition to which organic matter was present in drinking water in very small quantities, and always more or less mixed with other substances.

The subject might be divided into four parts:—1. The various ways in which water became contaminated. 2. The methods employed by analysts to detect and determine the extent of this contamination, with an opinion as to the probable value of these methods. 3. The bearing of the results of biological and microscopical investigations on the subject. 4. The utility of irrigation, chemical treatment, and filtration, for purifying purposes.

Under the first of these heads, the normal constituents of rain-water were considered, all of which were practically harmless, so that rain-water as it fell on the earth, or on the gathering grounds of a system of water-supply for a town, was unobjectionable, having contracted but an inappreciable amount of contamination. Spring-water was not so pure, owing to its percolation through strata from which various mineral substances were dissolved. River-water was the most objectionable, on account of the enormous quantities of animal and vegetable contamination which it acquired. Lastly, well-water varied greatly in quality, in some cases being excellent where the wells were deep and surface water was excluded, or when the district was thinly peopled; in other instances well-water was more contaminated than river-water, as in shallow wells in towns.

Under the second heading, the author pointed out that analytical chemists had hitherto been compelled to be content with the examination of the products of decomposition, or with the determination of one or two constituent elements of the organic impurities of water. Unfortunately the products of decomposition of the organic matter in water were the same as the normal constituents of rain, viz., carbonic acid, ammonia, and nitric acid. It was therefore impossible to ascertain whether those substances were derived from contaminating bodies or had been dissolved by the rain in falling.

The various processes of water analysis were then considered. In the first and oldest method a measured quantity of water was evaporated, and the residue was subjected to a red heat in a platinum dish. By this treatment the animal and vegetable substances were burnt away, and from the loss of weight the amount of organic matter was inferred. One great objection to this and the following process was the evaporation of the water. With such unstable bodies it was by no means improbable that a large portion was destroyed during the process.

By the second method the solid matter, left after

evaporation of a known quantity of the water, was mixed with an oxidising agent and heated to redness in a glass tube. The carbon and nitrogen of the organic matters in the residue were obtained in the form of carbonic acid and nitrogen gases, from which were deduced the weight of carbon and of nitrogen present as organic matter in the residue. This ratio of carbon to nitrogen did not, however, afford the slightest clue to the identity of the organic matter. It might be intensely poisonous or dangerous, or, on the other hand, harmless.

The albumenoid-ammonia method consisted in boiling the water with an alkaline oxidising agent, by which the organic matter was decomposed, and part of its nitrogen evolved in the form of ammonia. This had the great advantage of simplicity of manipulation, and was not open to the objection that previous evaporation was required.

The last considered was the permanganate method. In this the index of impurity was the amount of oxidising agent, namely, permanganate of potash, required to destroy the organic matter in the water. Inasmuch, however, as no relation had been established between the oxidability of a body and its action on the animal economy, this method would not afford reliable evidence of the fitness of a sample of water for drinking purposes or the reverse.

Under these circumstances the conclusion seemed inevitable, that the subject was as yet beyond the power of the analytical chemist.

It was, however, possible, by the second method, to determine approximately the minimum amount of contamination which had taken place since the water was precipitated as rain. For this purpose the whole of the nitrogen existing in the water was estimated, and the average amount in rain falling on the surface of the earth deducted. The remainder was due to animal and vegetable contamination, and it had been found convenient to express it in parts of average London sewage; that was to say, the sample was returned, as having been contaminated to the same extent as if pure rain-water had been mixed with so many parts of ordinary sewage. But this afforded no direct evidence as to its fitness for dietetic purposes, because subsequent oxidation and fermentation might have rendered the water to a great extent harmless.

The author next considered the bearing of biological research on the subject, pointing out that mere dilution had an almost inappreciable effect in disarming the germs of disease of their power. Thus, supposing a glass of water to contain but one germ, if the person taking it was sufficiently unhealthy or weakly, he would contract the disease almost as certainly as if there were hundreds of germs. In the author's opinion it would be impossible to banish zymotic disease from towns, the water supply of which contained the dejecta of persons suffering from the disease, even though present in the most minute quantity. The very weakly would contract the complaint from the water, and from them it would spread to the more robust around them. Again, these germs were endowed with such persistent vitality, that they withstood the effects of heat and cold, moisture, drought, and chemical agents to an almost incredible extent, affording what seemed, at first sight, indisputable evidence of the now exploded doctrine of spontaneous generation. From this it appeared that once-contaminated water was unsuitable for dietetic purposes.

In conclusion, the author contended that a radical change was the only remedy. Irrigation and chemical treatment were alike powerless; in addition to which, during heavy rain all existing sewerage systems were incapable of dealing with the huge volumes of water poured into them, and the sewage was allowed to flow direct into the river, to the manifest disadvantage of the towns below, who were dependent upon it for their water supply. Filtration, again, was powerless to effect real purification. The germs of disease were so minute that they could pass one hundred abreast through the interstitial spaces of ordinary sand, and dissolved substances were of course

* A Paper read at the Ordinary Meeting of the Institution of Civil Engineers on Tuesday, the 24th of January, Mr. Brunless, Vice-President, in the chair.

unacted upon. In view of the great increase in cancerous diseases of the stomach and intestines, the subject was worthy of the most careful study, and taking into consideration the unreliability of the results afforded by chemical analysis, the only way to ascertain if a sample of water was fit for drinking purposes was, in the author's opinion, to trace it to its source, and see that contaminating matter was excluded, from the time that the water fell as rain till it entered the reservoir or engine-well.

RESEARCHES ON THE COMPLEX INORGANIC ACIDS.*

By WOLCOTT GIBBS, M.D.,
Rumford Professor in Harvard University.

(Concluded from p. 52.)

PHOSPHO-MOLYBDATES.

44:2 Acid Potassium Salt.—This salt was prepared by boiling a mixture of potassic molybdate and phosphate with nitric acid in excess, when a beautiful yellow crystalline powder separated. This was washed with cold water and dried on woollen paper. Of this salt—

0.9850 grm. lost on ignition 0.0521 grm. = 5.28 per cent water.
0.8983 grm. gave 0.7943 grm. $\text{MoO}_3 + \text{P}_2\text{O}_5 = 88.42$ per cent.
2.0617 grms. gave 0.1201 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 3.72$ per cent.

These analyses lead to the formula—



or—
 $22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 3\text{K}_2\text{O} + 22\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 2\text{K}_2\text{O} \cdot \text{H}_2\text{O} + 21\text{aq},$
which requires—

		Calc.	
44MoO ₃	..	6336	84.62
2P ₂ O ₅	..	284	3.79
5K ₂ O	..	472	6.30
22H ₂ O	..	396	5.29
		7488	100.00

The salt is therefore the acid salt corresponding to a neutral salt with the formula—



Rammelsberg's analyses agree better with the formula of the acid salt given above than with that of the neutral compound assumed by him.

Twenty Atom Series.—The only salt of this series which I have obtained is one of ammonium prepared like the salts already described, having like these a fine yellow colour and a very fine-grained crystalline structure, and, like them, but slightly soluble in water. Of this salt—

1.0936 grm. lost on ignition with WO_4Na_2 0.0729 grm. = 6.66 per cent NH_3 and H_2O .
1.8183 grm. lost on ignition with WO_4Na_2 0.1155 grm. = 6.35 per cent NH_3 and H_2O .
0.8862 grm. gave 0.6153 grm. $\text{NH}_4\text{Cl} = 4.12$ per cent $(\text{NH}_4)_2\text{O}$.
1.3213 grm. gave 0.6224 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 4.19$ per cent P_2O_5 .
1.5135 grm. gave 0.6349 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 4.31$ per cent P_2O_5 .

The salt was dried on a water-bath, and afterward over sulphuric acid. The phosphoric oxide was precipitated twice, but not treated with ammoniac sulphide. The analyses led to the formula—



* Proceedings of the American Academy of Arts and Sciences, Communicated by the Author.

which requires—

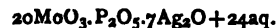
		Calc.			
60MoO ₃	8640	89.09	93.48	89.21	93.52
3P ₂ O ₅	426	4.39		4.31	4.19
8(NH ₄) ₂ O	416	4.29	6.52	4.12	6.50
12H ₂ O	216	2.23		2.54	
	9698	100.00			

If we calculate the composition of the mixed oxides of molybdenum and phosphorus existing in this salt, we have—

		Calc.		
20MoO ₃	..	2880	95.30	95.39
P ₂ O ₅	..	144	4.70	4.61
	3022	100.00	100.00	

It will be seen that the ratio is here very nearly as 20 : 1. This may, however, be merely accidental, and farther researches are necessary to fully establish the existence of a 20-atom series.

According to Debray, a solution of argentic nitrate gives with one of phospho-molybdic acid a precipitate which soon becomes crystalline, and which has the formula—



Such a salt would possess a twofold interest, first, as another evidence of the existence of a 20-atom series of phospho-molybdates; and, secondly, as showing that the acid of the series may unite with more than six atoms of base. On mixing the two solutions as above, I obtained a precipitate in small indistinct crystals of a greenish yellow colour. These crystals were soluble in hot water, but the solution was quickly decomposed with precipitation of a white powder. Under the microscope, with a high power and transmitted light, the salt appeared to consist of small tabular crystals mixed with a few long yellow prisms of very different habitus. Of this compound—

1.3604 grm. lost by ignition with WO_4Na_2 0.0692 grm. water = 5.08 per cent.
2.1099 grms. gave 0.8287 grm. $\text{AgCl} = 31.63$ per cent Ag_2O .
0.6733 grm. gave 0.2619 grm. $\text{AgCl} = 31.44$ per cent Ag_2O .
2.1099 grms. gave 0.0928 grm. $\text{P}_2\text{O}_7\text{Mg}_2 = 2.81$ per cent P_2O_5 .

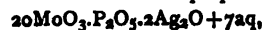
The phosphoric oxide was determined in the filtrate from the argentic chloride by double precipitation and treatment with ammoniac sulphide. The ratio of the molybdic to the phosphoric oxide is as 21 : 1, but the formula which most nearly represents the analysis is—



which requires—

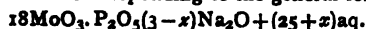
		Calc.		
22MoO ₃	..	3168	61.08	60.57
P ₂ O ₅	..	142	2.74	2.81
7Ag ₂ O	..	1624	31.32	31.44
14H ₂ O	..	252	4.86	5.08
	5186	100.00		

The only conclusion which can fairly be drawn from the analysis is that there is at least one phospho-molybdate in which the number of atoms of base exceeds three. It is certain that the salt does not represent a perfectly definite and homogeneous compound, and it may possibly be a mixture of the 20-atom salt, $20\text{MoO}_3 \cdot \text{P}_2\text{O}_5 \cdot 6\text{Ag}_2\text{O}$, and an acid molybdate of silver, $2\text{MoO}_3 \cdot \text{Ag}_2\text{O}$, nearly in atomic proportions. By dissolving the salt in nitric acid and evaporation, Debray obtained another salt in small brilliant yellow crystals. For this salt he proposes the formula—



but as usual he has given no analyses.

Eighteen Atom Series.—I have myself met with no salts belonging to this series, but according to Finkener* there are sodium salts corresponding to the general formula—



These salts are yellow and easily soluble.

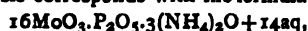
Sixteen Atom Series.—16 : 3 Ammonium Salt.—In preparing the 5 : 3 atom ammonium salt a white crystalline precipitate was formed, insoluble in cold, but soluble with decomposition in much boiling water, and easily soluble in ammonia. In this salt dried over sulphuric acid—

0.5100 grm. lost by ignition with WO_4Na_2 0.0722 grm.
= 14.16 per cent NH_3 and H_2O .

1.1653 grm. gave 0.1259 grm. NH_4Cl = 5.25 per cent $(\text{NH}_4)_2\text{O}$.

0.8114 grm. gave 0.0658 grm. P_2O_5 Mg_2 = 5.19 per cent P_2O_5 .

The analysis corresponds with the formula—



which requires—

		Calc.	Found.
16MoO ₃	.. 2304	80.73	80.65
P ₂ O ₅	.. 142	4.97	5.19
3(NH ₄) ₂ O	.. 156	5.46	5.25
14H ₂ O	.. 252	8.84	8.91
	2854	100.00	

FURTHER NOTES ON ACTINIUM, AND ON THE EQUIVALENT OF ZINC.

By Dr. T. L. PHIPSON, F.C.S., &c.

SINCE my last communication on Actinium in this Journal, and my letter to the Editor stating that the new metal had been isolated from its ammonio-chloride solution by means of magnesium, I have had little opportunity of pursuing these researches. The difficulty which I at first experienced of entirely separating all traces of zinc oxide from actinium oxide, by means of caustic soda, still subsists; so that the blowpipe reaction of oxide of actinium with chloride of cobalt is uncertain. The result is a mass of a magnificent dark emerald-green, a much finer and darker colour than is seen with purified zinc oxide; but how much of this is due to one or the other metal it is impossible to say at present.

The purified zinc oxide obtained, during these experiments, in a crystalline state from the soda solutions, has served me for a new determination of the equivalent of zinc, and the results all point very distinctly to the equivalent 32, which is a multiple by a whole number of H, and so according to the law of Prout. The method employed consisted in dissolving this purified zinc oxide in HCl, precipitating with pure carbonate of soda, washing, calcining, and converting a given weight of the oxide thus obtained into sulphide. The details will be published later.

I have also obtained a sulphide of actinium (in an allotropic form ?) which is only slightly sensitive to the action of light, whereas the ordinary sulphide darkens very visibly in a few minutes, and is quite black, or slate-coloured, on being exposed for twenty minutes to the sun. This intense darkening cannot be due, as some may suppose, to the presence of silver, mercury, cadmium, arsenic, &c., because the original liquor was, in the first place, submitted to HS for twenty-four hours, and next, because with actinium compounds the action does not occur under a sheet of glass.

In the latter respect actinium is interesting as bringing out a new and curious property of glass. Hitherto the compounds used in photography have been so sensitive

that the action of light, even under glass, is more or less instantaneous, and no difference has been observed. But with the ordinary actinium sulphide it requires at least twenty minutes, in good morning sunshine, to produce the dark grey tint, and in such an interval the action under a piece of plate glass about 2 millimetres thick is absolutely nil.

Glass has, therefore, the property of arresting a certain amount of actinic rays, as other transparent substances are known to arrest rays of heat—a property which glass possesses.

The plate glass used in these observations is slightly green on its section; but very similar results are obtained with various other kinds of white glass, even when much thinner than that mentioned. A fact which is still more curious is, that a plate of dark blue glass, which is supposed to allow actinic rays to pass easily, protects the substance in question from the sun's action just as much as a plate of white glass does.

London, February 3, 1882

ON SOME SALTS OF CHROMIUM AND MERCURY.

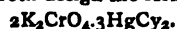
By F. W. CLARKE and DAVID STEARN.

THE double salts which mercuric chloride and mercuric cyanide form with certain alkaline chromates have long been known. The following have been described:—

1. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2 \cdot \text{H}_2\text{O}$ Darby, Richmond and Abel.
2. $3(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$ Richmond and Abel.
3. $\text{K}_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$ Millon. Darby.
4. $\text{K}_2\text{CrO}_4 \cdot 2\text{HgCl}_2$ Darby.
5. $\text{K}_2\text{CrO}_4 \cdot 2\text{HgCy}_2$ Poggiale. Calliot & Podevin.
6. $\text{Ag}_2\text{Cr}_2\text{O}_7 \cdot 2\text{HgCy}_2$ Darby.

These salts we have subjected to a re-examination, and we have sought to prepare others of the same series.

The first of the foregoing compounds was our chief object of study. Our results concerning the others may be stated briefly. Salts numbered 3 and 4 we prepared, but found them difficult to purify. To number 5, Darby and Rammelsberg both assign the formula—



This formula requires 9.09 per cent of chromium, while the one given above corresponds to 7.45 per cent. We found 7.62 per cent, thus confirming the simpler formula. The salt numbered 6 we found easy to prepare, and we verified its composition. We tried also to obtain a corresponding salt containing thallium in place of silver, but only thallium dichromate was deposited. We also attempted to produce double salts of mercuric cyanide with ammonium chromate, ammonium dichromate, and potassium dichromate, and of mercuric chloride with ammonium chromate; but in none of these experiments were we successful.

The salt numbered 1, and given by Richmond and Abel the formula $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2 \cdot \text{H}_2\text{O}$, is easily prepared. The salts represented in it are dissolved together in equivalent proportions, and from the concentrated solution the double compound is deposited in large showy crystals. As obtained by us, however, it was anhydrous. As formulated by Richmond and Abel, it should contain 3.33 per cent of water; but, as obtained by us, it lost no weight even after long heating at 150°. An estimation of chromium gave us 19.80 per cent. The theoretical percentage for an anhydrous salt is 19.88; for a monohydrated compound, 19.22.

From the mother-liquor of the foregoing compound, Richmond and Abel obtained the salt which we have numbered 2. This body we did not obtain. Various attempts were made to prepare it, but all were unsuccessful. Several crops of the original salt were deposited in

* Proceedings of the American Academy, p. 1639.

succession, and finally some orange-red laminae were secured, which were neither ammonium dichromate nor either of the double salts above referred to. They were, however, contaminated with mercuric chloride, and were not in sufficient quantity for purification and complete analysis. To the mother-liquor from them ammonia was added. A heavy dirty yellow precipitate was at first formed, which re-dissolved in an excess of the precipitant. The solution thus obtained deposited dark clove-brown granular crystals, also in quantity insufficient for thorough analysis. They were insoluble in cold water, but boiling water decomposed them, with separation of a yellow basic chromate of mercury. At 150° the crystals lost 1.68 per cent of their weight, and at 200° 16.66 per cent. 17.04 per cent of chromium, 8.89 of ammonia, and 43.70 of mercury were found in them, but no chlorine. From this meagre evidence we can deduce no probable formula; but we suspect the body to be a double salt of an ammonium chromate, with a chromate of one of the mercurammonium bases.

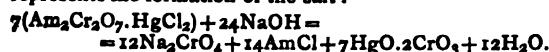
Upon adding a caustic alkali to a solution of the salt $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$, a yellow precipitate was thrown down, which proved to be a basic chromate of mercury. From hot solutions precipitates were formed of variable composition; but from cold solutions a compound was deposited consisting definitely of the salt $7\text{HgO} \cdot 2\text{CrO}_3$. Our analytical results were as follows, in percentages:—

	Ammonia Ppt.	Soda Ppt.	Theoretical.
Cr ..	6.08	6.09	6.07
Hg ..	80.74	81.41	81.77

The same compound was partially studied in this laboratory two years ago by Miss Helena Stallo, but her results were not published. She obtained the following percentages of chromium:—

	NH ₄ OH Ppt.	NaOH Ppt.	KOH Ppt.
Cr ..	6.09	5.96	6.07

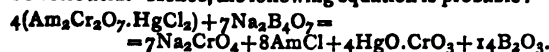
These figures are interesting, inasmuch as the same compound was prepared by a different process by Geuther,* whose results were afterwards discredited by Freese.† According to the latter chemist there is probably but one basic mercuric chromate, viz., the tribasic compound $3\text{HgO} \cdot \text{CrO}_3$. Our results confirm Geuther's, and from another line of investigation. The following equation represents the formation of the salt:—



The addition of a solution of borax to a solution of the salt $\text{Am}_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2$ also produces a yellow precipitate. This product agrees fairly with the formula $4\text{HgO} \cdot \text{CrO}_3$, as the subjoined figures show:—

	Found.	Theoretical.
Cr ..	5.10	5.38
Hg ..	82.34	82.88

The filtrate from this precipitate, upon concentration, gave white scaly crystals, which proved upon analysis to be boric acid. Hence, the following equation is probable:—



If, instead of borax, hydro-disodic phosphate be used for a precipitant, still another basic chromate is thrown down. It agrees approximately with the formula, $6\text{HgO} \cdot \text{CrO}_3$.

	Found.	Theoretical.
Cr ..	4.07	4.04
Hg ..	86.43	85.96

This corresponds to the subjoined equation,—
 $6(\text{Am}_2\text{Cr}_2\text{O}_7 \cdot \text{HgCl}_2) + 11\text{Na}_2\text{HPO}_4 = 11\text{Na}_2\text{CrO}_4 + 12\text{AmCl} + 6\text{HgO} \cdot \text{CrO}_3 + 11\text{HPO}_3.$

* Ann. Chem. Pharm., 106, 244.

† Poggend. Annal., 140, 7.

The last term in the equation was not verified, but it is suggested by the actual formation of boric acid in the previous case.

In conclusion, our results establish the existence of the basic chromate, $7\text{HgO} \cdot 2\text{CrO}_3$, and render the existence of two other basic chromates of mercury highly probable. All three are thrown down definitely from cold solutions, and all are more or less changed by boiling.—*American Chemical Journal.*

SOME NEW COMPOUNDS OF PLATINUM.

By F. W. CLARKE AND MARY E. OWENS.

THE action of potassium cyanate upon the compounds of platinum seems never to have been systematically studied. We have begun an investigation upon the subject, and now present some of our earlier results.

When cold alcoholic solutions of platinum tetrachloride and potassium cyanate are mixed, a pale buff-yellow precipitate is thrown down. If the mixture is heated, this precipitate undergoes partial decomposition, and what is apparently metallic platinum separates out. By filtration, washing with alcohol, and drying at ordinary temperatures over sulphuric acid, the precipitate may be obtained in a stable condition. It is soluble in water, but completely insoluble in alcohol, and its aqueous solution decomposes upon boiling. Analysis gives the following percentages, which agree with the novel formula $\text{K}_2\text{PtCl}_5(\text{CNO}) \cdot \text{H}_2\text{O}$.

	Found.	Theoretical.
Pt ..	38.41	38.44
Cl ..	34.79	34.74
K ..	15.08	14.67
C ..	2.27	2.35
H ₂ O ..	3.76	3.52

For want of sufficient material, nitrogen was not estimated. The presence of the cyanic molecule in the compound is, however, unquestionable.

By the action of potassium cyanate upon the green salt of Magnus, $\text{PtN}_2\text{H}_6\text{Cl}_2$, new compounds are formed, apparently of great complexity. The Magnus salt was prepared by the addition of a solution of potassium chloroplatinate to aqueous ammonia. A pure product is thus almost immediately formed, whereas the methods hitherto laid down for the preparation of this body gave us very unsatisfactory results. The Magnus salt dissolves readily in a hot aqueous solution of the cyanate, yielding a dark brown solution; which, concentrated over the water-bath to its crystallising point deposits pale yellow needles. From the mother liquor, beautiful clusters of brown needles were obtained. The yellow salt contained platinum, potassium, ammonia, water, and carbon; the platinum amounting to 43.93 per cent. In the brown crystals, ammonia, platinum, and chlorine were found. Both salts are to be systematically investigated.

One other new salt was incidentally obtained by us. The well-known potassium sulpho-cyano-platinate is prepared by the action of potassium sulpho-cyanate upon the chloro-platinate. Happening to have a quantity of the strychnia chloro-platinate on hand, we dissolved it in potassium sulpho-cyanate. The blood-red solution, which was obtained after short boiling, deposited on cooling a brilliant red crystalline precipitate. This proved to be the strychnia salt analogous to the potassium sulpho-cyano-platinate, and gave percentages of platinum and sulphur agreeing with the formula $2(\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2)\text{H}_2\text{PtCyS}_6$.

	Found.	Theoretical.
Pt ..	14.12	14.49
S ..	13.76	14.01

Doubtless other sulpho-cyano-platinates of alkaloids may be easily obtained.

The investigation of the products resulting from the action of cyanates upon platinites is to be followed up at an early day. The whole subject of the reactions between cyanates and salts of the various metallamines and metallammoniums bids fair to yield results of considerable interest.—*American Chemical Journal*.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 2, 1882.

Prof. A. W. WILLIAMSON, Vice-President, in the Chair.

THE following certificates were read for the first time:—H. S. Billing, W. G. Crook, W. Fowler, N. Graham, A. Hartley, A. Hill, F. Vacher.

THE CHAIRMAN then called on Dr. ODLING to deliver his lecture "On the Unit Weight and Mode of Constitution of Compounds." The lecturer said that it had been found useful to occasionally bring forward various points of chemical doctrine, on which there were differences of opinion, to be discussed by the Society. On this occasion he wished not so much to demonstrate certain conclusions, or to make a declaration of his opinions, as to invite discussion and a thoughtful consideration of questions of importance to chemists. Originally three questions were proposed:—First. Is there any satisfactory evidence deducible of the existence of two distinct forms of chemical combination (atomic and molecular)? Second. Is the determination of the vapour density of a body alone, sufficient to determine the weight of the chemical molecule? Third. In the case of an element forming two or more distinct series of compounds, *e.g.*, ferrous and ferric salts, is the transition from one series to another necessarily connected with the addition or subtraction of an even number of hydrogenoid atoms? He would, however, limit himself to the first of these questions, at the same time the three questions were so closely associated with one another that in discussing the first it was difficult to know where to begin. The answer to this question (Is there any satisfactory evidence deducible of the existence of two distinct forms of chemical combination?) depends materially on the view we take of the property called in text-books valency or atomicity; and before discussing the question it is important to have a clear idea of what these words valency and atomicity really mean. It is necessary, too, to start with some propositions which must be taken for granted. These propositions are:—First; that in all chemical changes, those kinds of matter which we commonly call elementary, do not suffer decomposition. Second. That the atomic weights of the elements as received, are correct, *i.e.*, that they do really express with great exactitude the relative weights of the atoms of the individual elements. If we accept these two propositions, it follows that hydrogen can be replaced atom for atom by other elements not only by the halogens but by alkali metals, &c. Hydrogen is, it may here be remarked, an element of unique character; not only can it be replaced by the elements of the widely different classes represented by chlorine and sodium, but it is the terminal of the series of paraffins C_nH_{2n+2} ; C_2H_6 , C_3H_8 , H_2 . The third proposition which must be taken for granted is, that the groups of elements C_2H_5 , CH_3 , behave as elements and that these radicals, ethyl, methyl, &c., do not suffer decomposition in many chemical reactions.

Now as to valency or atomicity, accepting the received atomic weights of the elements, it is certain that there are at least four distinct types of hydrogen compounds represented by ClH , OH_2 , NH_3 , CH_4 . The recognition of these types, and their relations to each other as types, was one of the most important and best assured advances made

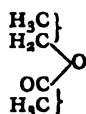
in theoretical chemistry. When we compare the formula of water with that of hydrochloric acid, we find that there is twice as much hydrogen combined with one atom of oxygen as there is combined with one atom of chlorine; and in a great many other instances, we find that we can replace two atoms of chlorine by one atom of oxygen, so that we get an idea of the exchangeable value of these elements, and we say that one atom of oxygen is worth two of chlorine or is bivalent; similarly, nitrogen is said to be trivalent. The meaning attached to the word valency is simply one of interchangeability, just as we say a penny is worth two halfpennies or four farthings. The question next arises is the valency of an element fixed or variable? If the word be defined as above, it is absolutely certain that the valency varies. Thus, tin may be trivalent, $SnCl_2$, or tetravalent, $SnCl_4$. Accordingly elements have been classed as monads, dyads, triads, &c. The lecturer objected most strongly to the word atomicity; he could not conceive of one atom being more atomic than another; he could understand the atomicity of a molecule or the equivalency of an atom, but not the atomicity of an atom; the expression seemed to him complete nonsense. He next considered the possibility of assigning a fixed limit to this valency or acidity of an atom, and concluded that the acidity was not absolutely fixed, but was fixed in relation to certain elements, *e.g.*, C never combines with more than four atoms of H; O never more than two atoms of H, &c. The acidity of an element when combined with two or more elements is usually higher than when combined with only one, *e.g.*, NH_3 , NH_4Cl . The term capacity of saturation may be used as a synonym for acidity, if care be taken to distinguish it from other kinds of saturation, such as an acid with an alkali, &c. Acidity is, however, quite distinct from combining force; the latter is indicated by the amount of heat evolved in the combination.

The lecturer then proceeded to criticise a statement commonly found in text-books, that chemical combination suppresses altogether the properties of the combining bodies. The reverse of this statement is probably true. To take the case commonly given of the combination of copper and sulphur when heated; this is good as far as it goes, but there are numerous instances, as ClI , SSe , &c., where the original properties and characters of the combining elements do not completely disappear. The real statement is that the original properties of the elements disappear more or less, and least when the combination is weak and attended with the evolution of a slight amount of heat, and in every case some properties are left which can be recognised. So with reference to the question of atomic and molecular combination, as atomic combination does not necessarily produce change it does not differ in this respect from what is usually called molecular combination.

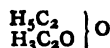
The lecturer then referred to an important difference in the acidity of chlorine and oxygen. Chlorine can combine with methyl or ethyl singly. Oxygen can combine with both and hold them together in one molecule. The recognition of this fundamental difference between chlorine and oxygen, this formation of double oxides as opposed to single chlorides, marks an epoch in scientific chemistry.

The lecturer then considered the subject of chemical formulæ; it is the bounden duty of every formula to express clearly the number of atoms of each kind of elementary matter which enters into the constitution of the molecule of the substance. A formula may do much more than this. If we attempt to express too much by a complex formula we may veil the number of atoms contained in it. This difficulty may be avoided by using two formulæ, a synoptic formula giving the number of atoms present, and a complex formula perhaps covering half a page giving the constitution of the molecule. But between the purely synoptic formula and the very elaborate formula there are others—contracted formulæ—which labour under the disadvantage, as a rule, of being one-sided, and so create a false impression as to the nature of

the substance. Thus, for instance, to take the formula of sulphuric acid, H_2SO_4 . This suggests that all the oxygen is united to the S; $(\text{HO})_2\text{SO}_2$ suggests that two atoms of hydroxyl exist in the molecule: then, again, we might write the formula HSO_3OH , or H_2OSO_3 . All of these are justifiable, and each might be useful to explain certain reactions of sulphuric acid, but to use one only creates a false impression. The only plan is to use them variously and capriciously, according to the reaction to be explained. Again, ethyl acetate may be written—



Or condensed—



Or $\text{H}_5\text{C}_2\text{O} \cdot \text{C}_2\text{H}_5\text{O}$, or $\text{H}_5\text{C}_2 \cdot \text{C}_2\text{H}_5\text{O}_2$. Now each of these two latter formulæ is a partial formula, each represents a one-sided view; it is justifiable if you use both, but unfair if you use only one.

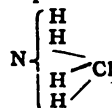
We now come to the question as to the existence or non-existence of two distinct classes of compounds, one in which the atoms are combined directly or indirectly with each other, and the other in which a group of atoms is combined as an integer with some other group of atoms, without any atomic connection, by so-called molecular combination. These two modes of combination are essentially distinct. The question is not one of degree. Are there any facts to support this theory that one set of compounds is formed in one way, another in a different way? Take the case of the sulphates: Starting with SO_3 , we can replace one atom of O by HO , and obtain $\text{SO}_2(\text{HO})_2$ or H_2SO_4 ; replacing a second atom, we get $\text{SO}(\text{HO})_3$ or H_3SO_5 , glacial sulphuric acid, a perfectly definite body corresponding to a definite class of sulphates, e.g., H_2MgSO_5 , Zn_2SO_5 , &c. By replacing the third atom of O we get $\text{S}(\text{HO})_6$ or H_6SO_7 ; this corresponds to a class of salts, gypsum, H_4CaSO_6 , &c. These are admitted without dispute to be atomic compounds. Are we to stop here? We may write the above compounds thus— H_2SO_4 , $\text{H}_2\text{SO}_4\text{H}_2\text{O}$, $\text{H}_2\text{SO}_4\text{H}_2\text{O}$. If we measure the heat evolved in the formation of the two latter compounds, it is, for $\text{H}_2\text{SO}_4 + \text{H}_2\text{O}$, 6·272; $\text{H}_2\text{SO}_4 + 2\text{H}_2\text{O}$, 3·092. But if we now take the compound $\text{H}_2\text{SO}_4 + 3\text{H}_2\text{O}$ we have heat evolved 1·744; so we can have $\text{H}_2\text{SO}_4\text{H}_2\text{O}$, &c. Where are we to draw the line between atomic and molecular combination, and why? It comes to this: All compounds which you can explain on your views of atomicity are atomic, and all that you cannot thus explain are molecular. Similarly with phosphates, arsenates, &c. In all these compounds it is impossible to lay one's finger on any distinction as regards chemical behaviour between the compounds called atomic and those usually called molecular.

Two points remain to be mentioned: The first is the relationship between alteration of acidity and two series (ous and ic) of compounds. Tin is usually said to be dyad in stannous compounds and a tetrad in stannic compounds, but in a compound like SnCl_2AmCl , is not tin really a tetrad?—



and yet it is a stannous compound, and gives a black precipitate with H_2S ; so that valency does not necessarily go with the series. The second point is that an objection may be urged, as, for example, in ammonium chloride (the lecturer stated above that here N was a pentad, the addition of the chlorine having caused the N to assume the pentadic character), it may be said, why should you

not suppose that it is the chlorine which has altered its valency, and that the compound should be written—

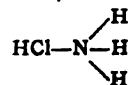


There is something to be said for this view, but on the whole the balance of the evidence is in favour of nitrogen being a pentad.

In conclusion the lecturer stated that his principal object was to direct the attention of chemists, and especially of young chemists, to the question: Is there or is there not any evidence derived from the properties, the decompositions, or the relative stabilities of substances to warrant us in believing that two classes of compounds exist, one class in which there is interatomic connection alone, and another in which the connection is molecular.

The CHAIRMAN said that at that late hour it was hardly possible to discuss the thoughtful and able address to which the Fellows had just listened. On his own behalf he might say that he had for some time past given much thought to the question as to how far certain theories were statements of facts, and he had come to the conclusion that it would be better to get rid of such phrases as molecular combination, &c., which were not statements of facts. Such phrases seemed, like the blinkers on a horse, only to shut out certain objects which we could not explain. It was better to refer to the unknown as unknown, and not give some fine scientific name to a reaction which we did not understand. The mind was only too ready to become satisfied with such a name and to accept the word as giving some account of the fact, and thus the motive for investigation is diminished, and the progress of knowledge hindered. He was inclined, too, to dispense with new words for old things, and he would prefer to use the old word "value" instead of Adicity or Valency. It was undesirable, too, to class elements as monads, dyads, &c., as their value varied under different conditions. Iodine, for instance, was usually called a monad; it certainly was not. In its most stable compounds it was a pentad or heptad; only in the unstable HI was it a monad.

Dr. ARMSTRONG said that according to L. Meyer there was reason to believe that some of the non-metallic elements behaved in different ways, e.g., the halogens when combined with the metals behaved as monads; with the non-metals, as polyads. So that there might be two different methods of combination. For instance, in ammonium chloride the N might be combined with the three atoms of H, as in ammonia, and the HCl add itself on—



Again that the compound SnCl_2AmCl gave a black precipitate with sulphuretted hydrogen seemed to him no proof that the compound was a stannous salt; it might be stannic and be decomposed by the sulphuretted hydrogen.

Dr. FRANKLAND must express his admiration of the excellent and logical discourse of Dr. Odling, but must confess that he was somewhat taken at a disadvantage by the ingenious title under which the lecturer had concealed the real subject of his lecture. He thought the term "atomicity" had something to be said for it; it lends itself, too, readily to the English language. As regards the gradation between atomic compounds and those usually called molecular, it must be remembered that in all departments of Nature it was difficult to fix the limit, as between plants and animals. As regards the very ingenious and forcible instances of the continued elimination of heat by the union of sulphuric acid and water, he would ask where are we to stop? He had carried the experiments down to moistening a piece of blotting-paper with pure water, and surely that was not a case of atomic combination, yet a certain amount of heat was evolved. He would protest, too,

against the capricious use of formulæ. It was difficult enough for students to follow the constitution of substances when the formulæ were on a uniform plan, and surely (though his contention might be unscientific) it would be doubly difficult if the formulæ were constantly changing.

Dr. ODLING said that though it would be easier for a student to use one form of partial formulæ he would take only a one-sided view of the substance, and surely it was worth the trouble to look at a substance from all sides rather than have a false impression by looking at it from one side only. As regards the question of gradation, he had pointed out that the difference between atomic and molecular compounds was one not of degree, but that the compounds must be quite distinct, and ought to show different reactions. As to the stannous chloride, he would take another example, which was still more clear. The compound $\text{Fe}_2\text{Cl}_4\text{KCl}$, which was green and was evidently a ferrous salt, yet the iron was there in the same condition as regards valency as in Fe_2Cl_6 .

After a few remarks from Dr. Wright and Mr. Cross, The Society adjourned to February 16, when the following papers will be read:—"On the Luminous Combustion of Ether at Temperatures below Redness," by W. H. Perkin; "Contributions to our Knowledge of the Composition of Alloys, for the most part Ancient," by Dr. Flight; "On the Preparation of Pure Nitrogen, and on the Action of Nitrogen and Hydrogen on Meteoric Silicates," by Dr. Flight; "On the Action of Sodium Carbonate and Hydrate on Felspar and Wollastonite," by Dr. Flight; "On Benzyl-phenol," by E. H. Rennie; "On the Buxton Thermal Water," by J. C. Thresh; "On Retrograde Phosphates," by T. F. Lloyd.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, February 6th, 1882.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair.

Sidney Biddell, Esq., M.A., the Earl of Dysart, and Mrs. Archibald Hamilton were elected Members of the Royal Institution.

Report from the Managers.—The following Resolution passed by the Committee of Managers at a Special Meeting held on December 16th, 1881, was read and adopted by the Members:—

1. The Board of Managers of the Royal Institution received with great regret Mr. Warren De la Rue's letter of December 3, 1881, addressed to Professor Tyndall, announcing that the state of his health compelled him to resign the office of Honorary Secretary to the Royal Institution.
2. The Managers fully appreciated the considerate offer made by Mr. De la Rue to continue in the post of Honorary Secretary for some time longer, if such a course were deemed desirable for the advantage of the Institution; but they believed it to be their duty to secure for Mr. De la Rue the immediate release from the cares of office which seemed indispensable.
3. The Managers trust that Mr. De la Rue may be enabled, after due rest and medical treatment, to resume those scientific pursuits in which so much of his life has been spent, and to the prosecution of which by others so much generous assistance has always been extended by him.
4. The Managers cannot bid farewell to Mr. De la Rue, as Honorary Secretary to the Royal Institution, without tendering to him their warmest thanks for the ability, zeal, and liberality with which he has aided the Royal Institution while filling that important office.
5. The devotion of Mr. De la Rue's time and attention to the interests of the Institution will always be

remembered with gratitude in connection with the services of other distinguished men, many of whose names, like his own, belong to the history of Science—a history to which the work done in the Royal Institution has made such signal contributions.

William Bowman, Esq., LL.D., F.R.S., was elected Honorary Secretary, and Warren De la Rue, Esq., M.A., D.C.L., F.R.S., was elected Manager.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for the same.

Thirteen candidates for membership were proposed for election.

CORRESPONDENCE.

PHOSPHORESCENCE.

To the Editor of the Chemical News.

SIR,—Captain Abney, although a noted photographic scientist, is certainly not *au courant* with the phenomenon of phosphorescence, since he has lately brought before the members of the Physical Society an account (CHEMICAL NEWS, vol. xlv., p. 52) of some experiments in connection with the above phenomenon, most of which have been known for at least thirty years.

If your readers will turn to vol. i., p. 196, of "Gmelin's Handbook of Chemistry," published in 1848, they will find the following:—"Phosphori which have been rendered luminous by colourless light cease to shine much sooner in red light than in the dark; and instantaneously when exposed to red light concentrated by a lens.—(Seebeck)."

"Light transmitted through blue glass makes Canton's phosphorus almost as luminous as colourless light concentrated by a lens; behind red glass, on the contrary, the phosphorus not only fails to acquire luminosity, but ceases to shine, when previously irradiated, much sooner than it would if placed in the dark.—(Seebeck)."

Of course, in answer to this, the Captain might say that Balmain's paint was not known thirty years ago; but if he will refer to vol. xli., p. 137, of the CHEMICAL NEWS, he will see the following, quoted from a lecture delivered before the Society of Arts, in March, 1880, by Professor Heaton, on "Balmain's Luminous Paint":—"If the experiment is carried on for a long time with a very intense spectrum, another effect which we could not have anticipated is observed in the lowest layer, which has previously been made luminous. The violet and ultra-violet rays increase the luminosity, as we might have expected, but the yellow and red rays not only do not add to the luminosity, but actually take away the light previously present. Another experiment will show this effect more quickly. Here is a sheet, at present luminous: I cover half of it with opaque cardboard, and the other half with yellow glass, and then burn a piece of magnesium in front of it. See the result. The rays which passed through the yellow glass have taken nearly all the light out of that half of the card, while the light on the other remains unimpaired."

In conclusion I may state that I was present at the lecture referred to, and saw this experiment successfully carried out.—I am, &c.,

A. J.

Spontaneous Combustion of Bengal Lights.—J. Clouet.—The author shows that the spontaneous explosion of mixtures containing potassium chlorate along with sulphur is generally due to a trace of sulphuric acid present as impurity in the latter substance, and he agrees with M. Du Moncel in rejecting the theory which ascribes such accidents to electric action.—*Journal de Pharmacie*,

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 2, January 7, 1882.

Methods of Coppering Cast-Iron in Use at Val-d'Osne.—MM. Mignon and Rouart.—The authors point out a distinction between their process and that of M. Weil. The latter uses a bath of copper sulphate rendered strongly alkaline, with an organic acid added to prevent the precipitation of copper oxide. MM. Mignon and Rouart, on the contrary, use a distinctly acid solution of a double salt of copper and any alkali with an organic acid.

Certain Consequences of the Principle of Gauss in Electrostatics.—M. Croullebois.—The author finds that in a system of fixed conductors, where two distinct states of equilibrium are considered, the sum of the products of the initial charge of each conductor and of the variation of its potential from one state to another is equal to the sum of the products of the initial potential, and of the variation of the charge. When conductors, kept at constant potentials, are left to their mutual actions, the energy of the system tends towards a maximum.

A Transmitter of Sounds with a Sounding-Board fitted with Strings.—M. Bourbouze.—If a sound is produced at a certain distance from the sounding-board (*? table d'harmonie*) of a piano, it is known that this board, as well as the strings which are in unison with the sound produced, or with one of its harmonics, enter into vibration. The author finds, on applying a microphone to such a board, that the sound transmitted in a circuit containing a telephone is considerably strengthened without any alteration either in its distinctness or in its quality, and upon this principle he has constructed a very sensitive transmitter.

Measure of the Internal Resistance and of the Electromotive Force of Electric Machines in Action.—G. Cabanellas.—The author uses a machine as a source making N turns per unit of time in a circuit of an arbitrary resistance. He observes by means of common galvanometers the intensity I , and the difference of potential ϵ at the limits of the machine. He then employs the machine as a motor receiving a current from any source; he regulates the friction by a brake placed on the axle of the machine so as to obtain the intensity I , and he varies the difference of potential absorbed by the machine till he obtains the speed N . He arrives at it either by acting upon the electromotor source and the resistance of the connection, or upon one of them only. He observes, then, the difference of the potential at ϵ' , E , and r , being the electric elements, and has the two equations:—

$$E = \epsilon + rI. \quad E = \epsilon' - rI.$$

Whence he deduces the values:—

$$E = \frac{\epsilon' + \epsilon}{2}, \quad r = \frac{\epsilon' - \epsilon}{2I}.$$

Note on the Theory of the Formiates.—Extract from a letter by M. Maumené.—The author contends that the results obtained by M. Riban are perfectly explained by his general theory.

Thermic Researches on the Sulphur Oxy-chlorides.—J. Ogier.—A thermo-chemical study of the chlorides of sulphuryl, thionyl, and pyro-sulphuryl.

Carbonic Ether of Borneol.—A. Haller.—The ether in question, $C_{21}H_{34}O_2$, forms very light and white hexagonal tables, insoluble in water and alkalies, soluble in boiling alcohol, in ether, chloroform, benzol, and glacial acetic acid. It melts at 215° , and sublimes without de-

composition. Its rotatory power varies with that of the borneol which has served for its preparation.

Formation of Bases of the Quindeic Series in the Distillation of Cinchonine with Potassa.—Ebsner de Coninck.—The author has isolated a tetra-hydroquinoleine, $C_9H_{11}N$, an intermediate product between the quinoleic and the pyridic series.

Terpine.—W. Walitzky.—The author has obtained and studied a derivative of terpene, $C_{10}H_{16}$, which he names terpine.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. Vol. 13, No. 12.

The Specific Heat and the Expansion of the Solid Elements.—H. F. Wiebe.—The total quantity of heat is according to the law of Dulong and Petit inversely proportional to the atomic weight, but shows when considered in itself no especial uniformities. But a regular relation appears, at least in certain groups, as soon as the entire heat introduced into a body up to the melting-point is taken into consideration, as the author shows in a table.

The Expansion and the Molecular Volume of Organic Liquids.—H. F. Wiebe.—The density of the fatty acids and their ethers may be calculated according to the formula—

$$\delta = \frac{A}{2(n+1) \cdot 3.542}$$

A signifies the molecular weight, and n the number of atoms in the molecule.

Amido-lactic Acid.—P. Melikoff.—This compound is formed by the action of ammonia upon α -chloro-lactic ether.

Preliminary Communication on the Behaviour of Phosphates with Ammonium Citrate.—A. Gruppe and B. Tollens.—The authors examine two points: upon what does the solvent action of ammonium citrate depend, and whether there exists an essential difference in the behaviour of this liquid with different phosphates; and, secondly, is the determination of phosphoric acid by direct precipitation with magnesia mixture from this solution sufficiently accurate? As regards the first question they conclude that the phosphates dissolved are converted into calcium citrate and ammonium phosphate. The differences of solubility do not depend on any essential feature. The results are sufficiently accurate if the magnesia mixture and the phosphoric acid are in certain proportions. A re-precipitation is, however, needed. Three times as much magnesia mixture should be used as the calculated quantity. A certain quantity of lime is also thrown down, and if the proportion of mixture is too great an excess of magnesia may be found in the precipitate.

Action of Iodine upon the Silver Salts of Certain Bibasic Acids of the Fatty Series.—K. Birnbaum and J. Gaier.—The silver and iodine combine, and the acid residue is resolved into anhydride and free oxygen.

Contributions to the Solution of the Question of the Constitution of Sulphones.—R. Otto.—An extensive memoir, not admitting of useful abstraction.

Synthesis of the Ethers of the Thiosulphonic Acids.—R. Otto.—The author caused an alcoholic solution of bromethyl to act upon potassium thio-benzol-sulphonate. The product was ethyl-phenyl-disulphoxide.

Sulphuretted Benzyl Compounds.—R. Otto and R. Lüders.—An examination of benzyl-sulph-hydrate, di-benzyl-sulphon, thio-benzoic-benzyl-ether, benzyl-sulphinic acid, and the behaviour of potassium benzyl-sulphonate with melting potash.

Behaviour of Mercury- and Lead-ethyl-mercaptides at Elevated Temperatures.—R. Otto.—The mercury compound is resolved at 180° to 190° into metallic mercury and ethyl-disulphide. The lead compound at the same temperature yields lead sulphide and ethyl sulphide.

Action of Sulphuric Acid upon Aromatic Mercaptans.—R. Otto.—Phenyl-sulph-hydrate is entirely converted by sulphuric acid at common temperatures into phenyl disulphide without the formation of by-products.

The so-called Toluol-meta-sulphonic Acid of Beckurt.—R. Otto.—This body is found to be a mixture of the para- and ortho-compounds.

Carbonic Oxide Hæmo-globin.—Th. Weyl and B. von Anrep.—The authors discuss the behaviour of hæmo-globin oxide and of carbonic oxide hæmo-globin with oxidising agents, and the reduction of methæmo-globin. Oxygen methæmo-globin and carbonic oxide methæmo-globin are found to be distinct bodies, though their spectroscopic behaviour is similar.

Constitution of Tetra-nitro-diphenyl-carbamide.—S. M. Losanitch.—A theoretical paper.

Substitutional Introduction of Phenyl Residues.—V. Merz and W. Weith.—Not suitable for abstraction.

Diphenic Anhydride.—C. Graebe and C. Mensching.—The authors treat of the formation and preparation of diphenic anhydride, its decomposition when heated, its phthaleines, and its behaviour with phosphorus chloride.

Preliminary Communication on Certain Derivatives of Orcine.—J. Stenhouse and C. E. Groves.—An examination of the views of Liebermann and Dittler on the constitution of penta-chlor-orcine.

Schizomycetic Fermentation.—A. Fitz.—Experiments on the fermentation of propionic acid and the normal valerianic acid obtained from calcium lactate.

Double Salts of the Lower Fatty Acids.—A. Fitz.—Not susceptible of useful abstraction.

Certain Remarks on the Vapour-density of Iodine.—J. M. Crafts.—Already noticed.

Thermo-Chemical Researches on the Theory of the Carbon Compounds.—J. Thomsen.—The author gives his results in the form of tables.

Furfurol.—E. Fischer.—An examination of furoine, furil, furil-o-cto-bromide, dibrom-furil, and benz-furoin.

Sequel to Homatropin.—A. Ladenburg.—The melting-point of homatropin is from 95.5° to 98.5°. Its composition is $C_{16}H_{21}NO_2$.

Determination of Nitrogen in Organic Substances.—C. E. Groves.—This paper requires the accompanying illustration.

Occurrence of Free Sulphur in the Dry Distillation of Coal Tar.—A. Kehlstadt.—Sulphur has been thus deposited at the Tar and Ammonia Works of C. Kurtz and Sons, Liverpool.

Transformation of α -Naphthyl-amine into α -Naphthyl-methyl-ether.—A. Hantzsch.—This transformation is a proof that the analogy between the derivatives of benzol and of naphthaline is less complete than is believed.

Transformations of Sulpho-cyan-methyl under the Influence of High Temperatures.—A. W. Hofmann.—At the temperature of 180° a part of the methyl-sulphocyanate is converted into methyl-thio-cyanate.

Archives Néerlandaises des Sciences Exactes et Naturelles.
Tome xvi., Livraison 5.

The Density and the Coefficient of Expansion of Diethyl-amin.—A. C. Oudemans, Jr.—The author gives a tabular view of the density of diethyl-amin at temperatures ranging from 0° to 55°. The value at the former figure is 0.7262, and at the latter 0.6680. Tables are also given for the change of volume.

Crystalline Form of α -Dinitro-dimethyl-aniline.—A. P. N. Franchimont.—Not capable of reproduction.

Journal de Pharmacie et de Chimie.
November, 1881.

On Levulose.—MM. Jungfleisch and Lefranc.—Levulose if moistened with alcohol and exposed to the air is deliquescent, but if freed from alcohol it is very slightly hygroscopic. It melts at 95°, and if heated to 100° it loses increasing quantities of water and yields ethereal derivatives. Its rotatory power deserves a special attention as presenting interesting peculiarities. It varies very rapidly with temperature, and notably with the dilution of the liquids in which it is observed.

December, 1881.

New Process for the Rapid Analysis of Opium.—MM. Portes and Langlois.—Take from an average sample 7 grms. of the opium; weigh out 3 grms. of slaked lime, and measure 70 c.c. of distilled water. Mix the opium and the lime very carefully, adding the water in small fractions, and leave the mixture for half an hour, stirring from time to time. Throw the whole upon a filter, and collect 53 c.c. of the liquid in a small glass provided with a lid. Add to the liquid 10 c.c. of ether, and agitate. Dissolve in the liquid 3 grms. ammonium chloride, agitating to promote solution, and let settle for two hours. Decant off the ether, put a fresh quantity in its place, agitate, and decant again. Collect the precipitate of morphia upon a filter without folds and 10 c.m. in diameter, and wash the precipitate and the vessel with a few c.c. of cold distilled water. Wash the precipitate into the vessel which has served for precipitation by means of 50 c.c. of distilled water. Add 5 c.c. of dilute sulphuric acid, containing 1.617 per cent by measure of SO_4H_2 , and 4 drops of neutral litmus. If the liquid becomes red the opium does not contain 10 per cent of morphine, but if it is blue it exceeds the normal standard. To find the deficiency or the excess: if the opium is too weak, drop in with the burette a standard alkaline solution till the liquid is neutralised; if too strong, an acid liquid is dropped in, in a similar manner.

MEETINGS FOR THE WEEK.

- MONDAY, 13th.**—London Institution, 5.
— Medical, 8.30.
— Society of Chemical Industry, 7.30. "Waste Products and Undeveloped Processes," by C. T. Kingzett. "A New Source of Potash Alum," by J. Spiller.
— Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.
- TUESDAY, 14th.**—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8. (Anniversary.)
— Royal Institution, 8. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.
- WEDNESDAY, 15th.**—Society of Arts, 8. "The Art of Turning," by P. N. Hasluck.
— Meteorological, 7.
- THURSDAY, 16th.**—Royal, 4.30.
— London Institution, 7.
— Royal Society Club, 6.30.
— Royal Institution, 8. "Geographical Distribution of Animals," by Dr. P. L. Sclater.
— Chemical, 8. "On the Luminous Combustion of Ether at Temperatures below Redness," by W. H. Perkin. I. "Contributions to our Knowledge of the Combustion of Alloys, for the Most Part Ancient." II. On the Preparation of Pure Nitrogen and on the Action of Nitrogen and Hydrogen on Meteoric Silicates." III. "On the Action of Sodium Carbonate and Hydrate on Kelp-ash and Wollastonite," by Dr. Flight. "Benzyl-phenol (Part II)," by E. H. Rennie. "On the Buxton Thermal Waters," by J. C. Thresh. "On Retrograde Phosphates," by F. J. Lloyd. "On the Dissociation of Chlorine," by W. Percy Smith.
- FRIDAY, 17th.**—Royal Institution, 8. "The Breathing of Fishes," by Professor J. G. M'Kendrick, 9.
— Society of Arts, 8. "The Depreciation of Silver as it Affects India," by J. M. Maclean.
— Geological, 8. (Anniversary.)
- SATURDAY, 18th.**—Royal Institution, 3. "The Iliad and Odyssey," by W. Watkins Lloyd.

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THE CHEMICAL NEWS

VOL. XLV. No. 1169

18 FEB 22

NOTE ON A FILTERING SYPHON FOR THE SEPARATION OF ETHER.

By C. J. H. WARDEN, Bengal Medical Staff,
Professor of Chemistry, Calcutta Medical College.

IN separating quinine and amorphous alkaloid from the mixed cinchona alkaloids by agitation with ether, the subsequent removal of the ethereal layer from undissolved alkaloid and from the aqueous stratum is an operation of some little difficulty. If the ether be decanted off, or taken up by a pipette, small quantities of solid matter, as well as watery fluid, are also likely to be removed, while the ordinary separating funnels do not facilitate the operation. To obviate these difficulties the following simple apparatus was devised, and has been found to answer well:—

The apparatus is essentially a filtering syphon, and consists of a syphon-shaped tube of thick glass, of small bore, on the shorter limb of which a small funnel has been blown, which is provided with a narrow projecting lip, and with a ground flat rim, while the other end of the larger limb is drawn out. The shorter limb is mounted on a cork, in which there is a second aperture, which carries a small bent tube. The cork fits the bottle in which the operation of agitation with ether has been conducted, and which should preferably be long and narrow.

To use the apparatus, the funnel is lightly stuffed with a few fragments of cotton-wool, and a piece of filter-paper tied over the mouth, the flange preventing it from slipping, and the superfluous paper cut off short. The funnel is then introduced a short distance below the surface of the ether, and the cork fixed. The apparatus has now somewhat the appearance of a wash-bottle, save that the tube from which the liquid escapes is three or four times the length of the tube which is immersed in the liquid. On gently blowing through the open end of the small tube—which may conveniently have a piece of india-rubber tubing attached—the ether is forced through the filter and fills both limbs of the syphon, and then continues to flow automatically into a reservoir placed for its reception.

As the ethereal stratum diminishes, the tube carrying the funnel is depressed until its flat surface is within a line or so from the surface of the aqueous layer, and is engaged in the precipitate. When this occurs air has again to be blown through the small tube, and this is continued until drops of ether escape only at long intervals. The cork carrying the tubes is then removed, fresh ether poured into the bottle, agitated, and the series of operations described above again performed; and this may have to be repeated a third time.

When it is judged that the precipitate has been exhausted of principles soluble in ether the syphon is removed, and any particles adherent to the base or sides of the funnel brushed off, and the funnel with its attached filter-paper, as well as the exit end of the syphon, washed with a small quantity of ether or alcohol.

Obviously the apparatus may be used for all operations in which ether, &c., is used for the separation of alkaloids or fatty principles. By having a third aperture in the cork and fitting into it the delivery tube of a burette, the apparatus could be employed in certain volumetrical analyses, the syphon-filter acting the part of a Beale's filter. Under such circumstances the tube carrying the funnel should be depressed until the mouth of the funnel is almost in contact with the bottom of the bottle, and the necessary agitation of the fluid, after addition of the precipitant, would then be effected by drawing air through it by the small bent tube.

In conclusion, I would wish it to be clearly understood that I do not claim originality for this little apparatus: it is merely an adaptation which I have found serviceable for a particular operation.

Medical College, Calcutta,
January 20th, 1882.

DETECTION OF TIN IN PRESENCE OF ANTIMONY.

By M. M. PATTISON MUIR, M.A.

THE test is founded on the fact that stannic chloride is reduced to stannous chloride by boiling with metallic copper.

The precipitated sulphides of the arsenic group are warmed with concentrated hydrochloric acid: the insoluble portion is washed and tested for arsenic by Bunsen's film test. The solution is somewhat diluted; about three-fourths of it is boiled for at least ten minutes with copper turnings (which must of course be free from tin), poured off from the copper, and tested for stannous chloride by adding mercuric chloride. The remaining smaller portion of the solution is poured on to a piece of platinum surrounded by a piece of zinc-foil. If the platinum become covered with a black deposit it is removed and examined in the ordinary way.

NOTE ON THE ACTION OF SULPHURIC ACID ON ZINC AND ON TIN.

By M. M. PATTISON MUIR, M.A., and C. E. ROBBS, B.A., B.Sc.

1. It was formerly noticed by one of us (see *Chem. Soc. Journ.*, 1880; *Trans.*, p. 427) that, when zinc is boiled with strong sulphuric acid, a point is reached at which evolution of gas slackens and sulphur begins to separate. A closer study of this reaction appeared likely to lead to results of some interest, as bearing on the general action of acids on metals, and on those phenomena which are usually explained by the hypothesis of "nascent" hydrogen.

A complete investigation of the action of zinc on sulphuric acid would involve much labour and consume much time. The results which we have to offer, although only qualitative, are yet, we think, of some value, especially when considered in connection with those recorded in a paper on Nascent Hydrogen by Gladstone and Tribe (*Chem. Soc. Journ.*, 1879; *Trans.*, p. 172).

2. We have qualitatively examined the action of sulphuric acid of various degrees of concentration, and at various temperatures, on zinc and on tin. The formulae given as representing the proportion of acid and water must be regarded as only approximately true. The specific gravity of "pure sulphuric acid" was determined by the hydrometer, and the quantity of water to be added calculated. "Pure granulated zinc" and "pure tin" cut, from sticks, into pieces as large as peas, were employed. Action proceeded in flasks connected with small bottles containing solution of lead acetate and an arrangement for drawing a current of air through the apparatus. Sulphur dioxide was tested for, partly by the smell and partly by passing the evolved gas into water and applying the ordinary tests to the liquid thus obtained. Of course very small traces of sulphur dioxide might escape detection, or small quantities might sometimes be actually formed, but be again decomposed by the sulphuretted hydrogen simultaneously evolved. The action was always stopped before the metal had completely dissolved.

The following tables contain the principal results:—

TABLE I.—ACTION OF SULPHURIC ACID ON ZINC.

Approximate Con- centration of Acid.	4° to 5°.	Ordinary (20° to 25°).	100°.	130° to 140°.	200° to 210°.
7H ₂ SO ₄ : 2H ₂ O				Very slight evolu- tion of H: no H ₂ S nor SO ₂ .	*No H ₂ S; much SO ₂ , and slight precipitate of S.
7H ₂ SO ₄ : 4H ₂ O					No H ₂ S: much SO ₂ , and large precipitate of S.
7H ₂ SO ₄ : 6H ₂ O					Much H ₂ S; no SO ₂ ; consider- able precipitate of S.
H ₂ SO ₄ : H ₂ O		Very slight evolu- tion of H. No H ₂ S nor SO ₂ .	A very little H ₂ S, accom- panying H.	More H ₂ S.	Very large amount of H ₂ S; large precipitate of S.
H ₂ SO ₄ : 2H ₂ O	Very slight action: H only.	Minute traces of H ₂ S.			Nearly pure H ₂ S, with very little S.
H ₂ SO ₄ : 3H ₂ O	Very slight action: minute traces of H ₂ S, with H.	Decided traces of H ₂ S.	Considerable amount of H ₂ S.	H ₂ S in quantity.	At 160° acid boiled, much H ₂ S, and no S
H ₂ SO ₄ : 5H ₂ O	Traces of H ₂ S, with H.	H ₂ S traces; rather more than at 5°.	H ₂ S decided.	H ₂ S decided; more than at 100°.	} These at tempera- ture of boiling acid.
H ₂ SO ₄ : 6H ₂ O	No H ₂ S: only H.	Only H.	Only H.	Very minute trace of H ₂ S.	
H ₂ SO ₄ : 7H ₂ O	Only H.	Only H.	Traces of H ₂ S.	Trace of H ₂ S; rather more than at 100°.	

* No H₂S evolved at any temperature: SO₂ began to come off a little above 150°.

TABLE II.—ACTION OF SULPHURIC ACID ON TIN.

	20° to 25°.	110° to 120°.
7H ₂ SO ₄ : 2H ₂ O	Very little action; no H ₂ S; slight precipitate of S; trace of SO ₂ .	Very slight trace of H ₂ S, large quan- tity of SO ₂ , and much S.
H ₂ SO ₄ : H ₂ O	Trace of H ₂ S; very small precipitate of S.	A little H, decided H ₂ S, much SO ₂ , and a little S.
H ₂ SO ₄ : 3H ₂ O	No action.	H ₂ S given off in quantity; SO ₂ absent or mere trace. No S.
H ₂ SO ₄ : 5H ₂ O	No action.	H evolved, with trace of H ₂ S.
H ₂ SO ₄ : 7H ₂ O	No action.	Very slight action; a little H evolved.

} These at temp.
of boiling acid.

3. When the conditions of our experiments agree with those of the experiments of Calvert and Johnson (*Chem. Soc. Journ.*, 19, 434), the general results also agree. These chemists carried out no experiments with tin at ordinary temperatures: in the action of zinc at ordinary temperatures they appear to have noticed the evolution of hydrogen only.

The tables show that strong sulphuric acid—(7H₂SO₄ : 2H₂O), exerts no action on zinc until a high temperature is reached, and that the gaseous product of the action which then occurs is SO₂, accompanied by separation of a little sulphur; that the action of rather more dilute acid (7 : 4 mols.) is similar, but that more sulphur separates than with the stronger acid; that with an acid approximately of the strength 7H₂SO₄ : 6H₂O, sulphur dioxide is no longer produced, but only H₂S and sulphur; and that as the acid becomes more dilute action begins at lower temperatures with evolution of hydrogen only, or hydrogen with minute traces of H₂S, which last-named gas increases in quantity as temperature rises, but is not accompanied by sulphur or sulphur dioxide. Strong sulphuric acid begins to act on tin at ordinary temperatures, but the amount of action is very small: the gaseous product is SO₂, accompanied by a very slight separation of sulphur. As temperature rises, the quantities of both these substances increase and a little H₂S begins to appear. With a more dilute acid (1 : 1 mol.) H₂S comes off at a lower temperature, while at about 120° we have evolution

simultaneously of H, H₂S, and SO₂, and separation of S. More dilute acids have little or no action until the temperature approaches the boiling-point of the acids, when the gaseous products are hydrogen and sulphuretted hydrogen, or in the case of H₂SO₄ : 7H₂O hydrogen only, no sulphur being formed with these acids.

The general tendency is towards production of hydrogen and sulphuretted hydrogen when the amount of water present is considerable. As the water decreases the production of sulphuretted hydrogen increases, until a point is reached—approximately H₂SO₄ : H₂O—after which sulphur dioxide and sulphur are the chief (in the case of zinc the only) products.

The white solid substances produced in the flasks were collected in several cases, dried on a porous tile, and treated with dilute acid: in no case was a trace of sulphuretted hydrogen or sulphur dioxide produced. Therefore, we conclude that neither zinc nor tin sulphide is a product of the action under examination, and that therefore the production of sulphur, sulphur dioxide, or sulphuretted hydrogen is not to be traced to a secondary action between the acid and metallic sulphide produced in the primary change. In this respect the actions under consideration differ from that of sulphuric acid on copper (compare Pickering, *Chem. Soc. Journ.*, 1878; *Trans.*, p. 112, *et seq.*), and more nearly resemble that of nascent, or occluded, hydrogen on sulphuric acid (see Gladstone and Tribe, *loc. cit.*).

It seems very probable that the reduction of moderately

dilute sulphuric acid, with production of H_2S , noticed in these experiments, is to be traced to the action of nascent hydrogen, evolved by the primary action of the metal on the acid. But that the production of sulphur dioxide and sulphur from more concentrated acids is partly conditioned by the ease with which strong sulphuric acid undergoes dissociation, aided by the action of nascent hydrogen on the acid itself, and also on its dissociation products. The rapidity of evolution of the hydrogen must also influence the result; and that the nature of the metal used also modifies the action is shown by the fact that sulphur dioxide and sulphur are produced—from the same acid—at a much lower temperature by the action of tin than by the action of zinc.

ON
PEROXIDE OF HYDROGEN AS A MEANS FOR
BLEACHING, AND ITS
AVAILABILITY FOR TECHNICAL, MEDICINAL,
AND CHIRURGICAL PURPOSES.*

According to the researches of Schœnbein ozonised oxygen is said to be the active principle in grass bleaching. Later and extremely exact researches by Emil Schœne have, however, proved, in conformity with the opinions of A. Houzeau and Fr. Goppelsrœder, that ozone is not engendered in the air during the process of bleaching, but rather, that all the reactions ascribed to the influence of ozone are due to the action of peroxide of hydrogen. Continued quantitative analyses to ascertain the air's titre of peroxide of hydrogen led to the perception that it depends in a great measure on external circumstances, such as the time of year and day, the movements of the air, &c., and Schœne is of opinion that the preponderating influence in its production must be ascribed to the light.

Atmospheric precipitations, particularly hoar-frost originating under certain conditions, contain considerable quantities of peroxide of hydrogen, namely 0.04 to 1 milligramme in one litre of liquid.

The quantities come to earth within 4 months amounted to 62.9 milligrams. per square metre.

Although "grass bleaching," bleaching with water, light and air, has been exercised with success for thousands of years, and though there was no lack of time and labour for the perfection of the process, yet there cannot be any misconception as to the fact that it is attended with considerable inconveniences. The result of grass bleaching can never be predicted with absolute certainty, especially within a fixed time. The usual way of bleaching mostly requires a great deal of time, and is attended, besides other drawbacks, with great loss of interest.

It will be sufficient to point to the extremely interesting operation of wax bleaching. There is lying at the wax bleachfields near Celle, material to the value of hundreds of thousands of marks, waiting for sunshine and wind. The consideration of these drawbacks will suffice to demonstrate how necessary it is to produce the bleaching medium of nature, the peroxide of hydrogen, in a concentrated form.

Chemistry has at its disposal a long series of combinations which contain oxygen only loosely bound, and which transfer it by their own decomposition to other bodies. These media of oxidation offer a base for the compensation of the oxygen of the air in bleaching, and the following are being technically used: nitric acid, nitrous acid, permanganic acid, chloric acid, chromic acid, and lastly the chloric gas in combination with bases, in the shape of bleaching salts. However manifold these bleaching

media may be, the use of all of them is attended with inconvenience, as they more or less injuriously affect the fibre to be bleached, and for this reason their application is limited and difficult. It is the peroxide of hydrogen alone which does not act in that way; it contains the effective agent operating in grass bleaching in a concentrated form, and is therefore superior to all other bleaching media, and in so far must be marked as the bleaching media of the future.

The peroxide of hydrogen was discovered in 1818 by Thenard, who obtained it by the action of acids on peroxide of barium in the presence of water. Thenard showed, that the oxygen of the peroxide of barium operated as an oxidiser on the water.



A great number of chemists afterwards occupied themselves with the peroxide of hydrogen; Pelouze, Duprey, Balard, J. Thomson, E. Schœne. All of them found the above way for its production the most preferable.

There always result solutions of a titre of only 5 per cent peroxide of hydrogen. The parting of the pure product H_2O_2 is proportionately difficult, on account of its great tendency to decompose. There are two ways for effecting concentration.

(1.) Freezing out. (2.) Evaporation in the vacuum over sulphuric acid at a temperature of 15° to 20° C. (59° to 68° F.)

The pure peroxide of hydrogen is a syrupy liquid of 1.453 sp. gr., which yields a 475-fold volume of oxygen in its decomposition. Diluted solutions equal solution of chlorine in their effect, and will keep for months in a temperature not exceeding 25° C. (77° F.) if protected from the influence of light. A trifling addition of acid has the effect of diminishing very considerably the tendency to decompose. On the other hand, alkalies and salts producing basic reaction hasten its decomposition.

This tendency of the peroxide of hydrogen to lose its oxygen places it amongst the media of oxidation. It is not in every case that the real reasons are known for the peroxide of hydrogen quickly surrendering its oxygen. There is a series of bodies which accelerate the evolution of oxygen, without themselves apparently undergoing a change. For instance all pointed, angular, sharp objects, precipitates, such as alumina and hydrated peroxide of iron, charcoal, then several metals when very finely grained, as silver, gold, platina.

In a second series of cases the peroxide of hydrogen acts in the same way as any other medium of oxidation in yielding its oxygen to another body. In course of this process arsenious acid is oxidised to arsenic acid, sulphides are converted into sulphates.

Thirdly, peroxide of hydrogen can apparently act reductive, losing a portion of its oxygen in decomposing other oxidised bodies. In this manner it reduces the peroxides of lead and of manganese to oxide and protoxide.

In general it may be said, that the peroxide of hydrogen has a deoxidising action on acids which have an inclination to yield their oxygen (permanganic acid), oxidising on oxides in alkaline solution which have the opposite tendency.

Application of the Peroxide of Hydrogen for Technical Purposes.

Almost every one who has treated of the subject of peroxide of hydrogen has predicted for it great future importance; the characteristic reactions almost obtrude themselves upon one's observation.

Dumas ("Handbook of Practical Chemistry," Nürnberg, 1830, vol. 1, page 119) had used it for cleaning discoloured oil paintings and valuable drawings. Starting, as he did, from the consideration that the fading of the paintings arose from the discolouration of the lights put on with white-lead, through the formation of sulphide of lead, and having regard to the regeneration of the latter

* A Lecture delivered by Dr. P. Ebell, Technical Director of the Chemical Works of E. de Haen at List near Hanover, at a meeting of the Branch Society of German Engineers at Hanover. From the *Industrie Blätter* of January 7th, 1882.

by the influence of peroxide of hydrogen into white sulphate of lead, success could not but follow the trials. —In spite of all that the peroxide was not made use of for a long time; it was only in 1870 that an intelligent perfumer employed it, making it an article of commerce in shape of a 3 per cent watery solution, as a means for bleaching the hair, and under various names as:—"Eau de fontaine de Jouvence, golden," "Golden hair water," "Auricome." About the same period prominent men drew attention to the faculty of reaction possessed by the peroxide of hydrogen as a recommendation for its use in medicine. A. v. Schroetter, R. Boettger (*Annals of Chemistry*, 1873, p. 365), then Geiger (*Handbook of Pharmacy*, 1, page 213, 4th edit.). Hager also states methods for its production in his "Pharmaceutical Practice."

If in spite of all this peroxide of hydrogen played only a subordinate part, especially in medicine, the reasons are to be found on the one hand in the slighting treatment which was accorded to it by practical chemistry, on the other in its own most valuable and specific peculiarities, which in certain directions were antagonistic, and which to superficial observation seem still inimical to its being taken into general use.

In the first place the production of the peroxide of hydrogen, so far as regards quantities and purity of the article, was until lately an unsolved problem.

What practical chemistry could offer were only solutions charged with impurities in the shape of various salts and acids, and of the most uncertain and varying composition. For this reason alone uniform, thorough success in any direction could not be attained. But besides that the price could not be but enormous in consequence of the disability to fully exhaust the materials used in its manufacture, and an entire want of demand for the article. These drawbacks are now overcome, and peroxide of hydrogen can be had in watery solution with a titre of 3 per cent by weight, or of 10 volumes, in a uniform, chemically pure state at low prices and in large quantities.

The doubts with regard to durability and to transport to distant parts may be considered as solved.

The watery solution corresponds in its conditions to solution of chlorine; when light is excluded, and temperature does not exceed 25° C. (77° F.), it loses only a trifling amount of its entire titre of peroxide of hydrogen, and therefore the "Peroxide of hydrogen question" must be considered answered with regard to its first part, comprising its chemical production and its capacity of undergoing unharmed the difficulties of transport.

With regard to the second part, its "technical use," the following remarks, which are based on our own practical observation, are destined to serve as "directions."

Peroxide of Hydrogen as Bleaching Material for Products of Animal Origin.

All products, which are to be subjected to a bleaching process by peroxide of hydrogen must be submitted to a preparatory treatment, the purpose of which is to render them capable in every part of being moistened by a watery solution of the peroxide of hydrogen. Every particle of fat, sweat, and impurity adhering to the objects to be bleached must be taken away.

Besides bathing in a solution of good soap, solutions of 3 to 5 per cent of carbonate of ammonia have in the first place shown themselves of value; in various cases new means of solution, such as sulphide of carbon, benzene, ether, &c., have been found available.

With regard to the process of bleaching itself, two different principles can be brought into operation.

The watery solution of 10 volume peroxide of hydrogen is neutralised as far as possible by some drops of liquid ammonia and then used directly as a bleaching bath.

For a continued process of bleaching it is advisable to use a series of baths, through all of which the object to be bleached passes systematically, commencing

with the weakest. Light must be excluded, and temperature not be allowed to exceed 25° C. (77° F.)

The second method is based on the same principle, but carried out in a different way.

The objects preliminarily prepared as above stated are steeped in the solution of peroxide of hydrogen. After being fully impregnated with the liquor, they are taken out and subjected to a process of drying in a current of air, which must not exceed a temperature of 20° C. (68° F.).

The process of bleaching progresses energetically during the evaporation of the water, and the concentration of the solution of peroxide of hydrogen occasioned thereby.

It is a matter of calculation, or depends upon other circumstances, whether the one or the other proceeding is to be carried through.

Bleaching of Hair with 3 per cent Solution of Peroxide of Hydrogen.

The hair was digested for 12 hours in a solution of 3 parts carbonate of ammonia in 100 parts of water at a temperature of 30° C. (86° F.), rinsed, then washed with soap, and all the fatty matter removed with the help of a fresh solution of carbonate of ammonia. Benzene can also be recommended. Prepared in this way, it was immersed in a bath of peroxide of hydrogen, fully neutralised with liquid ammonia.

It remained either in the bath until sufficiently bleached, or was dried in a room at ordinary temperature, and the immersion repeated.

The baths must only be considered fully exhausted, when some drops of permanganate of potash produce in the liquor a permanent red colouration.

It has not been found feasible to bleach black hair so that it becomes perfectly white, its colour only disappearing so far as to arrive at a light golden fair hue. Even a jet black Chinese tail did not resist.

The bleaching of hair even on living persons does not present any difficulties. After the desired degree of bleaching has been arrived at, an after treatment by washing with water, followed by a wash with alcohol, takes place; hot liquids or drying in drying chambers are excluded.

Bleaching of Feathers, especially Ostrich Feathers with Peroxide of Hydrogen.

As a means of bleaching feathers, the peroxide of hydrogen is far superior to all other substances proposed for the same purpose, and has proved itself of value in every way, especially for ostrich feathers.

Its superiority rests especially on the oxidation and thorough removal of colouring matter, without the slightest detriment to the structure of the feather itself.

By way of preparation the feathers are placed into a bath of carbonate of ammonium containing 1 to 2 parts of salt in 100 parts of water, where they are left for 12 hours at a temperature of 20° C. (68° F.), being gently moved about in the bath the while.

After this they are being steeped and moved about in a luke-warm bath of Marseilles soap, and at last well rinsed with water exempt from lime. Boiling or hot liquids must be excluded.

Treatment with pure benzene and ether has also shown very good results.

For feathers it is only admissible to bleach in baths, which must be made neutral, and not be prepared and kept in metal or wood vessels. Earthenware, or stone-ware vessels are the best adapted for the purpose.

In cases where the feathers are for a long time exposed to the influence of slightly acidulated liquid, there occur, as with all other organic matter, appearances of wasting away in the liquid; they begin to show signs of decay, and lose their beauty to a great degree.

The bleaching finished, the feathers are slowly dried in a low temperature and in moving air, while being repeatedly beaten. At higher temperature the formation of gluey matter easily takes place, in consequence whereof

the finest fibrils stick together; beating acts as a preventive to that drawback.

It has formerly been proposed to dust the feathers while still in a damp state with hair powder, and then only to dry them.

The powder acts on the feathers in a similar way as do tanning materials in tanning; like these it prevents the tendency to flaw.

Very favourable results may be attained by steeping the bleached and still wet feathers in alcohol; this makes the gluey insoluble formations settle down, and the liquid evaporating at very low temperature, it leaves the feathers of woolly and beautiful appearance. By steeping the feathers in benzene, and allowing it to evaporate, the same end is gained with even better results.

The further treatment of the feathers, as scraping, trimming, and curling, can be only mentioned here in passing.

The success of the bleaching of feathers in the above manner is thorough in comparison with other proceedings.

Even entirely black spots are bleached after continued action of the bath.

Bleaching of Silk with Peroxide of Hydrogen.

For bleaching silk a whole series of strong oxidisers, as permanganic acid, chromic acid, nitric acid, have been proposed, and besides them sulphurous acid has been used to advantage. As is the case with bees'-wax, the colouring matters of raw silk are capable of resisting bleaching materials in different degrees; some sorts of silk are easily susceptible to their influence, while others resist it strongly.

Amongst the latter is the product of the wild silkworm, the so-called Tussah silk, a fine and durable thread of strongly pronounced brown colour.

According to our trials, peroxide of hydrogen is the best means of bleaching this silk, the objectionable brown colour being reduced by its action to a but little distinguishable, pleasing yellow. After the boiling of the gum by subjecting the raw silk to a treatment with soap baths of various strengths, and final boiling in concentrated solutions of soap, it is recommended to treat it with carbonate of ammonia.

After that, the scoured silk must be subjected to the action of peroxide of hydrogen, in the same way as mentioned under the heading of "bleaching of hair."

Alcohol, eventually mixed with a little glycerin, has in this case also shown itself of value for an after-treatment.

Bleaching of Ivory and Bone.

Records as to the bleaching of bony substances and ivory are very scarce.

Almost universally the process of bleaching in sunlight by means of air and water, which is very trying to the bone, is being had recourse to; for ivory chloride of lime has been proposed.

The outward layers of the bone are constant; they encircle the inner membrane enclosing the marrow, being themselves covered by their skin.

Besides organic substances, such as fat and cartilage or gelatinous substance, they contain 70 to 80 per cent of phosphate of lime, carbonate of lime, and fluoride of calcium.

The purpose of the preparation of the bone is, as in the case of all the other substances heretofore mentioned, the removal of fatty matter. While formerly they were treated with steam under pressure, and the fat skimmed off, there have lately been patents taken out for using solvents, such as sulphide of carbon, ether, benzene, and it is said that their use offers advantages as compared with the former way of proceeding, not only with regard to quality and quantity of fatty matter, but also in consequence of the loss of gelatinous substances being only trifling.

Lyes of carbonates of alkalies must be more or less excluded for the above purpose, but weak solutions of carbonate of ammonia may be used.

The bones freed from fatty matter are immersed—preferably while in a primary state of manufacture—in an almost neutral solution of peroxide of hydrogen, and left in this bath as long as may be requisite. The process of bleaching takes place smoothly and safely; even spots where remainders of blood have been left behind in the pores in a dried state acquire a perfectly white appearance.

Ivory is treated in exactly the same way as bones; fans, handles of walking sticks, and knife handles, bleached by peroxide of hydrogen are already being used very extensively.

The methods, according to which it is feasible to use the peroxide of hydrogen as a means for bleaching in various ways, and in a practical manner, have been treated of in the foregoing in a general way; by following them, products of considerably higher value will be obtained than was possible by adhering to former practices.

It will, however, be the task of those interested in the use of the peroxide of hydrogen to further develop the process of bleaching in special cases, and to adapt it to their particular requirements.

Application of Peroxide of Hydrogen for Medicinal Purposes.

The peroxide of hydrogen has not hitherto played a conspicuous part in therapeutics. The reason for that may be, that formerly pure and durable solutions were not to be had at a reasonable figure. Price, however, is no longer an impediment to its use, and the tendency of the peroxide of hydrogen as at present obtainable to decompose, can be considerably restricted; possibly peroxide of hydrogen turned into simple water may formerly have led to wrong conclusions. Peroxide of hydrogen if preserved in the dark, and in a temperature not exceeding 25° C. (77° F.), keeps unaltered for months. For ascertaining its titre of active oxygen a normal solution of permanganate of potash is requisite; it would be advisable to fix a minimum titre of active oxygen. It is to be supposed that peroxide of hydrogen, like chloride, bromide, and permanganate of potash, is poison to the smallest organisms (bacteria); exact comparative experiments with a view to ascertain this are much to be desired, considering the importance of the matter. Experiments with yeast instituted by the lecturer had very favourable results, and proved that the germs of the yeast are entirely killed by peroxide of hydrogen, even when greatly diluted.

As regards the fitness of peroxide of hydrogen, for treating wounds, caused by syphilitic, scrophulous, and tuberculous ulcers, favourable experience has been gleaned by a physician at Hanover. It is probable that peroxide of hydrogen will do good service in the shape of spray in making operations and ligatures; this would be important, considering the effect which carbolic acid spray often has on operators and patients.

The great advantages possessed by peroxide of hydrogen, as compared with other media of disinfection, are:—

- (1) Complete want of smell.
- (2) Yielding oxygen without leaving any other residuum but pure water.
- (3) Absence of injurious influence on the organism.

The workmen occupied in making the peroxide of hydrogen get exceedingly delicate hands, and wounds heal visibly under its influence.

There further seems room for employing the peroxide of hydrogen as a means of disinfecting sick chambers and generally for purifying the air. It would be advisable to spread by means of a rafraichisseur spray of diluted peroxide of hydrogen by way of trial.

Attention must also be drawn to the use of peroxide of hydrogen in dentistry, as has in the first place been done by C. Sauer (*Quarterly Review of Dentistry*, 1870, No. IV.) Sauer made use of the peroxide of hydrogen with success in bleaching discoloured and carious teeth. In cases where the teeth are covered with coloured matter (*Lichen dentalis* &c.) he employs peroxide of hydrogen in conjunction with

finely levigated pumice stone as a means of cleaning, in place of water. Teeth, the native channels of which were filled with coloured matter, became somewhat paler after several applications. A suitable liquid for cleaning teeth and mouth is prepared by mixing 1 part of 3 per cent peroxide of hydrogen with 10 parts of water. In case of carious teeth the peroxide of hydrogen on wadding was locally used with advantage.

CELESTIAL CHEMISTRY FROM THE TIME OF NEWTON.*

By T. STERRY HUNT, LL.D., F.R.S.

THE late W. Vernon Harcourt, in 1845,† called attention to the remarkable perception of great chemical truths which is apparent in the Queries appended to the third book of Newton's "Optics," as well as in his Hypothesis touching Light and Colour. With regard to the latter, Harcourt then remarked, "It has, I think, scarcely been quoted, except by Dr. Young, and its existence is but little known, even among the best-informed scientific men." The essay in question was read before the Royal Society, December 9th and 16th, 1875, but remained unpublished till 1757, when Birch, at that time Secretary to the Society, printed it, not without verbal inaccuracies, in the third volume of his "History of the Royal Society"—a work intended to serve as Supplement to the *Philosophical Transactions* up to that date. In 1846, at the suggestion of Harcourt, the Hypothesis of Newton was again printed in the *L. E. and D. Philosophical Magazine* (vol. xxix.), and it subsequently appeared in the Appendix to the first volume of Brewster's "Memoirs of Sir Isaac Newton," in 1855.

The time has come for further inquiries into the science of Newton, and I shall endeavour to show that a careful examination of the writings of our great natural philosopher, in the light of the scientific progress of the last generation, renders still more evident the wonderful prevision of him who already, two centuries since, had anticipated most of the recent speculations and conclusions regarding cosmic chemistry.

As an introduction to the inquiries before us, and in order to show the real significance of the speculations of Newton, it will be necessary to review, somewhat at length, the history of certain views enunciated almost simultaneously by the late Sir Benjamin Brodie, of Oxford, and the present writer, and subsequently developed and extended by the latter. In Part I. of his "Calculus of Chemical Operations," read before the Royal Society, May 3, 1866, and published in the *Philosophical Transactions* for that year, Brodie was led to assume the existence of certain ideal elements. These, he said, "though now revealed to us through the numerical properties of chemical equations only as *implicit and dependent existences*, we cannot but surmise may sometimes become, or may in the past have been, *isolated and independent existences*." Shortly after this publication, in the spring of 1867, I spent several days in Paris with the late Henri Sainte-Claire Deville, repeating with him some of his remarkable experiments in chemical dissociation, the theory of which we then discussed in its relations to Faye's solar hypothesis. From Paris, in the month of May, I went, as the guest of Brodie, for a few days to Oxford, where I read for the first time and discussed with him his essay on the "Calculus of Chemical Operations," in which connection occurred the very natural suggestion that his ideal elements might perhaps be liberated in solar fires, and thus be made evident to the spectroscopist. I was then about to give, by invitation, a lecture before the Royal Institution on "The Chemistry

of the Primeval Earth, which was delivered May 31, 1867. A stenographic report of the lecture, revised by the author, was published in the *CHEMICAL NEWS* of June 21, 1867, and in the *Proceedings of the Royal Institution*. Therein I considered the chemistry of nebulae, sun, and stars in the combined light of spectroscopic analysis and Deville's researches on dissociation, and concluded with the generalisation that the "breaking-up" of compounds, or dissociation of elements, by intense heat, is a principle of universal application, so that we may suppose that all the elements which make up the sun, or our planet, would, when so intensely heated as to be in the gaseous condition which all matter is capable of assuming, remain uncombined,—that is to say, would exist together in the state of chemical elements,—whose further dissociation in stellar or nebulous masses may even give us evidence of matter still more elemental than that revealed in the experiments of the laboratory, where we can only conjecture the compound nature of many of the so-called elementary substances."

The importance of this conception, in view of subsequent discoveries in spectroscopy and in stellar chemistry, has been well set forth by Lockyer in his late lectures on Solar Physics,* where, however, the generalisation is described as having been first made by Brodie in 1867. A similar but later enunciation of the same idea by Clerk-Maxwell is also cited by Lockyer. Brodie, in fact, on the 6th of June, one week after my own lecture, gave a lecture on Ideal Chemistry before the Chemical Society of London, published in the *CHEMICAL NEWS* of June 14th, in which, with regard to his ideal elements, in further extension of the suggestion already put forth by him in the extract above given from his paper of May 6, 1866, he says "We may conceive that in remote ages the temperature of matter was much higher than it is now, and that these other things [the ideal elements] existed in the state of perfect gases—separate existences—uncombined." He further suggested, from spectroscopic evidence, that it is probable that "we may one day, from this source, have revealed to us independent evidence of the existence of these ideal elements in the sun and stars."

During the months of June and July, 1867, I was absent on the Continent, and this lecture of Brodie's remained wholly unknown to me until its republication in 1880, in a separate form, by its author,† with a preface, in which he pointed out that he had therein suggested the probable liberation of his ideal elements in the sun, referring at the same time to his paper of 1866, from which we have already quoted the only expression bearing on the possible independence of these ideal elements somewhere in time or in space.

The above statements are necessary in order to explain why it is that I have made no reference to Sir Benjamin Brodie on the several occasions on which, in the interval between 1867 and the present time, I have reiterated and enforced my views on the great significance of the hypothesis of celestial dissociation as giving rise to forms of matter more elemental than any known to us in terrestrial chemistry. The conception, as at first enunciated in somewhat different forms alike by Brodie and myself, was one to which we were both naturally, one might say inevitably, led by different paths from our respective fields of speculation, and which each might accept as in the highest degree probable, and make, as it were, his own. I write, therefore, in no spirit of invidious rivalry with my honoured and lamented friend, but simply to clear myself from the charge, which might otherwise be brought against me, of having, on various occasions within the past fourteen years, put forth and enlarged upon this conception without mentioning Sir Benjamin Brodie, whose only publication on the subject, so far as I am aware, was his lecture of 1867, unknown to me until its reprint in 1880.

It was at the grave of Priestley, in 1874, that I for the second time considered the doctrine of celestial dissociation.

* Read before the Cambridge Philosophical Society, November 28, 1881, and reprinted from its *Proceedings*.

† *L. E. and D. Phil. Mag.*, III., xxviii., 106 and 478; also xxix., 185.

* *Nature*, August 25, 1881, vol. xxiv., p. 396.

† "Ideal Chemistry, a Lecture," Macmillan, 1880.

tion, commencing with an account of the hypothesis put forward by F. W. Clarke, of Cincinnati, in January, 1873,* to explain the growing complexity which is observed when we compare the spectra of the white, yellow, and red stars; in which he saw evidence of a progressive evolution of chemical species, by a stoichiogenic process, from more elemental forms of matter. I then referred to the further development of this view by Lockyer, in his communication to the French Academy of Sciences, in November of the same year, wherein he connected the successive appearance in celestial bodies of chemical species of higher and higher vapour-densities with the speculations of Dumas and Pettenkofer as to the composite nature of the chemical elements.† I then quoted from my lecture of 1867 the language already cited, to the effect that dissociation by intense heat in stellar worlds might give us more elemental forms of matter than any known on earth, and further suggested that the green line in the spectrum of the solar corona; which had been supposed to indicate a hitherto unknown substance, may be due to a "more elemental form of matter, which, though not seen in the nebulae, is liberated by the intense heat of the solar sphere, and may possibly correspond to the primary matter conjectured by Dumas, having an equivalent weight one-fourth that of hydrogen." The suggestion of Lavoisier, that "hydrogen, nitrogen, and oxygen, with heat and light, might be regarded as simpler forms of matter from which all others are derived," was also noticed in connection with the fact that the nebulae, which we conceive to be condensing into suns and planets, have hitherto shown evidences only of the presence of the first two of these elements, which, as is well known, make up a large part of the gaseous envelope of our planet, in the forms of air and aqueous vapour. With this I connected the hypothesis that our atmosphere and ocean are but portions of the universal medium which, in an attenuated form, fills the interstellar spaces; and further suggested, as "a legitimate and plausible speculation," that "these same nebulae and their resulting worlds may be evolved by a process of chemical condensation from this universal atmosphere, to which they would sustain a relation somewhat analogous to that of clouds and rain to the aqueous vapour around us.‡

These views were reiterated in the preface to a second edition of my "Chemical and Geological Essays," in 1878; and again before the British Association for the Advancement of Science, at Dublin,|| and before the French Academy of Sciences in the same year.§ They were still further developed in an essay on the "Chemical and Geological Relations of the Atmosphere" (published in the *American Journal of Science* for May, 1880), in which attention was called to the important contribution to the subject by Mr. Lockyer in his ingenious and beautiful spectroscopic studies, the results of which are embodied in his "Discussion of the Working Hypothesis that the so-called Elements are Compound Bodies," communicated to the Royal Society, December 12, 1878. It was then remarked that the already noticed "speculation of Lavoisier is really an anticipation of that view to which spectroscopic study has led the chemists of to-day;" while it was said that the hypothesis put forth by the writer in 1874, "which seeks for a source of the nebulous matter itself, is perhaps a legitimate extension of the nebular hypothesis."

To show the connection of the above views with the philosophy of Newton, it now becomes necessary to give some account of the conception of the universal distribution of matter throughout space, both as regards its dynamical relations and its chemical composition. Passing

over the speculations of the Greek physiologists, we come to the controversies on this subject in the seventeenth century, and find, in apparent opposition to the plenum maintained by Descartes and his followers, the teaching of Newton that "the heavens are void of all sensible matter." This statement is, however, qualified elsewhere by his assertion, that "to make way for the regular and lasting movements of the planets and comets, it is necessary to empty the heavens of all matter, except perhaps some very thin vapours, steams, and effluvia arising from the atmospheres of the earth, planets, and comets, and from such an exceedingly rare ethereal medium as we have elsewhere described," &c. ("Optics," Book III., Query 28).

In order to understand fully the views of Newton on this subject, it is necessary to compare carefully his various utterances, including the Hypothesis, in 1675, the first edition of the "Principia," in 1687, the second edition, in 1713, and the various editions of the "Optics." This work appeared in 1704, the third book, with its appended queries, having, according to its author's preface, been "put together out of scattered papers" subsequent to the publication of the first edition of the "Principia." The Latin translation of the "Optics," by Dr. Clarke, which was published in 1706, and the second English edition, in 1718, contain successive additions to these queries, which are indicated in the notes to Horsley's edition of the works of Newton, and are important in this connection. From a collation of all these we learn how the conceptions of the Hypothesis took shape, were reinforced, and in great part incorporated in the "Principia."

In the Hypothesis he imagines "an ethereal medium much of the same constitution with air, but far rarer, subtler, and more elastic." "But it is not to be supposed that this medium is one uniform matter, but composed partly of the main phlegmatic body of ether, partly of other various ethereal spirits, much after the manner that air is compounded of the phlegmatic body of air intermixed with various vapours and exhalations." Newton further suggests in his Hypothesis that this complex spirit or ether, which, by its elasticity, is extended throughout all space, is in continual movement and interchange. "For Nature is a perpetual circulatory worker, generating fluids out of solids, and solids out of fluids, fixed things out of volatile, and volatile out of fixed, subtle out of gross, and gross out of subtle; some things to ascend and make the upper terrestrial juices, rivers, and the atmosphere, and by consequence others, to descend for a requital to the former. And as the earth, so perhaps may the sun imbibe this spirit copiously, to conserve his shining, and keep the planets from receding farther from him; and they that will may also suppose that this spirit affords or carries with it thither the solar fuel and material principle of life, and that the vast ethereal spaces between us and the stars are for a sufficient repository for this food of the sun and planets."

The language of this last sentence, in which his late biographer, Sir David Brewster, regards Newton as "amusing himself with the extravagance of his speculations," at which "we may be allowed to smile,"* was not apparently regarded as unreasonable by its author when, more than ten years later, he quoted it in the postscript of his letter to Halley, dated Cambridge, June 20, 1686. The views therein contained, with the single exception of the suggestion regarding gravitation, have not wanted advocates in our own time, and many of them were embodied in the "Principia," which Newton was then engaged in writing.

But this was not all: Newton saw in the cosmic circulation, and the mutual convertibility of rare and dense forms of matter, a universal law, and rising to a still bolder conception, which completes his Hypothesis of the Universe, adds: "Perhaps the whole frame of Nature may be nothing but various textures of some certain ethereal spirits or vapours, condensed, as it were, by precipitation,

* Clarke, "Evolution and the Spectroscope," *Popular Science Monthly*, New York, vol. ii., p. 32.

† Lockyer, *Comptes Rendus*, November 3, 1873.

‡ "A Century's Progress in Theoretical Chemistry; being an Address at Northumberland, Penn., July 31, 1874," *Amer. Chemist*, vol. v., pp. 46-61, and *Popular Science Monthly*, vi., p. 430.

§ *Nature*, August 29, 1878, vol. xviii., p. 475.

|| *Comptes Rendus*, Sept. 23, 1878, vol. xxviii., p. 452.

* Brewster's "Memoirs of Newton," vol. i. pp. 121 and 404.

much after the same manner that vapours are condensed into water, or exhalations into grosser substances, though not so easily condensable; and after condensation wrought into various forms, at first by the immediate hand of the Creator, and ever since by the power of Nature, which, by virtue of the command 'Increase and multiply,' became a complete imitator of the copy set her by the great Protoplast. Thus, perhaps, may all things be originated from ether."

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Annual General Meeting, Saturday, February 11th, 1882.

Prof. W. GRYLLS ADAMS in the Chair.

THE PRESIDENT read the Report of the Council for the past year, from which it appeared that in this, the tenth year of the Society, it was in a highly satisfactory condition and numbered 331 members. Sir Charles Wheatstone's papers had been published, Dr. Joules's were soon to be so, and delegates from the Society had taken part in the Electrical Congress at Paris, the Lightning Rod Committee, &c.

The TREASURER (Dr. Atkinson) read the Audited Report of the financial state of the Society: and the following officers were, after a ballot, declared elected for the ensuing year:—

President—Prof. R. B. Clifton, F.R.S.

Vice-Presidents—Sir W. Thomson (past President), Prof. G. C. Foster, Prof. F. Fuller, Dr. J. Hopkinson, Lord Rayleigh.

Secretaries—Prof. A. W. Reinold, Prof. W. Chandler Roberts.

Treasurer—Dr. E. Atkinson.

Demonstrator—Prof. F. Guthrie.

Other Members of Council—Prof. W. G. Adams, Prof. W. E. Ayrton, Mr. Shellford Bidwell, Mr. Walter Baily, Prof. J. A. Fleming, Mr. R. J. Lecky, Dr. Hugo Müller, Prof. Osborne Reynolds, Prof. A. W. Rücker.

Honorary Member—Prof. G. Quincke.

Votes of thanks were then passed to the Lords Commissioners of the Committee of Council on Education for the use of the Meeting Hall, to the past President (Sir W. Thomson), to the Secretaries, the Treasurer, and Demonstrator, as well as to the Auditors, Mr. Shellford Bidwell and Mr. E. Rigg.

Prof. ADAMS then resolved the meeting into an ordinary one, and called Prof. Clifton to the Chair.

Dr. C. R. ALDER WRIGHT, F.R.S., then read a paper "On the Relation between the Electromotive Force of a Daniel Element and the Chemical Affinity involved in its Action." The author has investigated the causes which lead to a fall of E.M.F. in a Daniell cell when in action. He found the amount of fall for increasing current densities and plotted it in a curve. The fall was slight when pure commercial or amalgamated zinc, or zinc coated with a film of copper, was employed. Amalgamated copper plates gave more rapid rates of fall than electro-coated ones. Dilute sulphuric acid round the zinc gave a less rapid fall than sulphate of zinc solution round it. In all cases no appreciable fall was noticed when the current did not exceed 8 micro-Ampères per square centimetre of plate surface. With four to six times this density a decrease of E.M.F. from 0.5 to 1 per cent resulted; and with currents exceeding 3000 micro-Ampères in density per square centimetre of surface the fall exceeded 10 per cent. A series of experiments were made to determine the fall due to change in the density of the solution by migration of the ions, causing a stronger zinc

and a weaker copper solution. This showed that with nearly saturated zinc sulphate solution (sp. gr. 1.4) and very dilute copper sulphate solution, the maximum fall in E.M.F. is developed, and is less than 0.04 volt. Hence the total fall in E.M.F. due to migration of the ions when moderately strong currents pass, is only a fraction of the total fall. It follows that the energy due to the actions taking place in the cell, although wholly manifested as electric action expressible in Volt-Coulombs when the current is very small, is not wholly so manifested when the current is stronger. The author expresses this idea by calling the energy manifested in electric action *adjuvant* and the remainder as *non-adjuvant*. He finds that the major part of the latter energy is absorbed in actions having their seat at the surface of the copper plate, and the rest in actions at the surface of the zinc plate. It is transformed into heat according to Joule's law. As a subsidiary result it appears that the E.M.F. of a Daniell cell with zinc and copper sulphate solutions of equal specific gravity, or pure amalgamated zinc plate, and either a freshly deposited copper or an amalgamated copper plate, is a standard subject to less departure from the E.M.F. of other Daniell cells than the Clark's standard elements, which appear to vary one from another. On the other hand, a Clark cell keeps sensibly constant to its original value (if properly set up) during a period of months or years at a constant temperature, whereas a Daniell standard falls from its original value after a few hours, or days at most.

NOTICES OF BOOKS.

The Practice of Commercial Organic Analysis. By ALFRED H. ALLEN, F.I.C., F.C.S., Lecturer on Chemistry at the Sheffield School of Medicine, &c. Volume II., Hydrocarbons; Fixed Oils and Fats; Sugars; Starch and its Isomers; Alkaloids and Organic Bases, &c. London: J. and A. Churchill.

MANY of our readers will be glad to hear of the appearance of this long-promised volume. The first part of Mr. Allen's work so clearly supplied a want, that the necessity for a book treating of previously-omitted portions of the subject has been the more felt. The volume just published is half as large again as Volume I., and is based on a similar plan. In his preface the author expresses regret that the growth of the subject-matter has compelled him to omit several important sections, but a feeling that it was better to ignore a subject entirely than to treat it inadequately had caused him to postpone their consideration till a demand should arise for an additional volume or a second edition of those already published. On the subjects treated in the volume under review Mr. Allen writes fully and in many cases exhaustively, though it is only to be expected that in a book dealing with such a variety of material those sections should be most elaborate which treat of bodies in the examination of which the author has had special experience.

In the chapter on "Hydrocarbons" the author gives a useful table showing the various organic products respectively obtained by the distillation of coal, bituminous shale, peat, wood, and petroleum. Full details are given of the methods of assaying petroleum and shale products, including lubricating oils, vaseline, and paraffin wax. Turpentine, essential oils, and rosin oil are described in the section on "Terpenes," and then follow valuable and suggestive sections on "Benzene and its Homologues," "Naphthalene," and "Anthracene." The descriptions of the methods of assaying commercial benzols and coal-tar naphthas, and of examining crude anthracene deserve special mention, as they are by far the most complete account yet published, and ought to render the book indispensable to tar distillers and managers of gas works.

The next division of the volume is devoted to "Fixed Oils and Fats;" but fatty acids, bees'-wax, spermaceti, and soaps receive full descriptions in sections under the same general head. The chapter on "Fixed Oils and Fats" occupies 140 pages of the volume, and in our opinion is likely to be one of the most widely appreciated portions of the work. It forms a valuable addition to a much neglected and difficult branch of applied chemistry, and will be useful even if regarded merely as a carefully compiled *résumé* of isolated observations and tests. Under certain heads, however,—as, for example, "Sperm Oil," "Hydrocarbon Oils in Fixed Oils," and the "Temperature-reactions of Oils,"—the author adds to the general value of the chapter by the results of personal observations.

In the next division Mr. Allen gives an account of the optical assay of sugars, sections on the density of saccharine liquids, and the assay of cane-sugar, commercial glucose, malt, honey, and other products.

The chapter on "Starch and its Isomers" perhaps contains less of novelty than the other divisions of the work, but will be valuable for the tabulated scheme for the proximate analysis of plant products, which has been compiled from the directions of Prescott. Full directions are also given for the detection of adulterations of flour and bread.

The concluding chapter is devoted to the consideration of the "Alkaloids and Organic Bases," which are arranged under seven heads. The section dealing with Cinchona Alkaloids is one of the most complete descriptions of these bases in the English language, and the Opium Alkaloids are also fully treated. The reactions of and methods of isolating strychnine are detailed at length, but the less important vegetable alkaloids receive in many cases a very meagre description. Full directions are given for the assay of aniline oils, and there is an interesting and concise description of the leading basic derivatives of aniline. Instructions are also given for the examination of the leading aniline dyes for adulterants, and for the recognition of various dyes on tissues.

Although the volume is open to the charge of being somewhat unequally written, it is, on the whole, a valuable contribution to chemical literature. It is certainly calculated to increase the reputation of the author, and is an indispensable addition to the library of all who require to examine any of the numerous products of which the author treats.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 3, January 16, 1882.

Speed of Propagation of Explosive Phenomena in Gases.—MM. Berthelot and Vieille.—The general mean speed of propagation in a tube, whether curved or straight, 0.005 metre in diameter, is 2810 metres per second. The material of the tube is indifferent. The speed is sensibly the same whether the tube is open or closed. The differences observed in tubes of different lengths fall within the limits of error. Under the circumstances of the authors' experiments the speed of propagation of detonation, either with a mixture of oxygen and hydrogen, or of oxygen and carbon oxide, is independent of the degree of pressure. The introduction of an inert gas retards the detonation.

Chemical Studies on the Skeleton of Plants. Part Second: Vasculose.—MM. E. Frey and Urbain.—Vasculose is insoluble in all neutral solvents. It is unaffected by boiling in dilute sulphuric, hydrochloric, and phosphoric acids. It resists the action of trihydrated

sulphuric acid and of boiling alkaline solutions. Concentrated sulphuric acid acts upon it slowly, dehydrating it and changing its colour. Vasculose is rapidly attacked by all oxidising agents such as nitric acid, chromic acid, permanganates, chlorine, the hypochlorites, bromine, &c., producing a series of resins. Those first formed are not sensibly soluble in alcohol; those afterwards formed dissolve both in alcohol and ether. In decaying wood the normal proportion of vasculose is much reduced, as it has been converted by the gradual action of the atmosphere into resins, such as those above mentioned, which are dissolved away by alkalies and ammonia. The formula assigned to vasculose is $C_{36}H_{29}O_{16}$.

Influence of the Form of Polar Surfaces upon the Explosive Potential.—J. B. Baille.—For a given explosive length the potential is at its maximum when the spark plays between two spheres of the same diameter. It deviates so much the more from the maximum as the difference of the curvature of the poles is greater and as the potential is higher.

Essence of Savory (*Satureia montana*).—A. Haller.—The author expected to find in this essence a camphor, of which, however, it does not contain a trace, being a mixture of hydrocarbides and phenols. Carvacrol is present to the extent of 35 to 40 per cent. The carbides appear to be terpenes.

A Diatomic Alcohol derived from β -Naphthol.—G. Rousseau.—The alcohol in question is a white crystalline powder, which melts with decomposition at 230° . Its composition is represented by $C_{22}H_{14}O_2$. It is insoluble in alkalies. If heated in the water-bath with sulphuric acid it dissolves to a blood-red liquid, having a splendid green fluorescence.

Phosphoric Acid in the Arable Soils of the North of France.—A. Ladureau.—The author shows by observation and analysis that the opinion entertained of the inutilty of phosphatic manures is unfounded.

Justus Liebig's Annalen der Chemie,
Band 210, Heft 2 and 3.

Researches from the Chemical Institute of the University of Strasburg.—These consist of a memoir by Siegmund Levy and Gustav Schultz, on the chlorine and bromine derivatives of quinon; a paper on the action of ammonia and amine-bases upon chlorinised quinons, by H. v. Knapp and G. Schultz; and researches on a new mode of formation of diphenylene, and on a new isomer of this compound, by H. Strasse and G. Schultz.

Determination of the Chemical Affinity of the Metals for Oxygen according to the Heats of Combination, as compared with the Determinations according to the Volume-Proportions.—W. Müller-Erbach.—The author concludes that, as far as the heavy metals are concerned, the degree of the affinity for oxygen can be more accurately determined, but that for all the light metals the results thus obtained are contradictory to all other experience. On the other hand, the results deduced from the change of volume are in agreement with the older tables of affinity; so that, for the class of oxygen compounds in question, the deduction of the affinities from the contractions appears the more trustworthy.

Incomplete Combustion of Gases.—Konrad Botsch.—This paper is incapable of useful abridgment.

Contributions to the Knowledge of the Benzoyl Compounds.—O. Doebner.—In this memoir the author examines the benzoyl derivatives of the phenols, including benzo-phenol and some of its salts, benzhydryl-phenol, the action of the benzoyl chloride upon phenyl acetate, the behaviour of benzoyl chloride upon resorcin, benzo-resorcin and its derivatives, benzo-pyro-catechin, and dibenzo-hydroquinon. He then passes to benzo-aniline, phthalyl-benzo-anilide, benzo-phenyl-isocitril, benzo-phe-

nyl-sulphurea, and the transformation of benzo-aniline into benzo-phenol. Lastly, he investigates benzoyl-benzoic acid.

On Combinations of the Carbo-hydrates with Alkalies.—Dr. Th. Pfeiffer and B. Tollens.—The authors examine successively the combinations of the alkalies with starch, with cane-sugar, with amylo-dextrin, with dextrin, and inulin. They conclude that a conclusion may be formed as to the molecular magnitude of the substances of the starch series by the aid of the alkaline compounds of these carbo-hydrates. The formulæ which they have deduced may perhaps be considered merely as minimal quantities. Starch may be considered as $C_{24}H_{40}O_{20}$, including four starch-groups $C_6H_{10}O_5$. The formula of cane-sugar, $C_{12}H_{22}O_{11}$, is confirmed. Inulin requires a formula with 12 atoms of carbon, and cannot therefore be placed parallel with starch. The molecular magnitude of dextrin is much smaller than that of starch, and approaches more to that of the sugars and of inulin. Amylo-dextrin sodium prepared from crude amylo-dextrin has given figures which approximate to those of the corresponding starch compounds. Amylo-dextrins obtained by freezing, precipitation, &c., give figures agreeing more or less with those of dextrin, inulin, and cane-sugar.

Bismuth-Iodide Compounds of Organic Bases.—K. Kraut.—Not susceptible of useful abstraction.

On Anhydro-Compounds.—(A continuation).—H. Hübner.—The author examines first the anhydro-compounds of para-toluylic acid and the diamides. Secondly, para-toluylic acid and toluylen-diamine; para-toluylic acid and xylylen-amine; the amido-anhydro compounds; anhydro-benzamido-toluylic acid, anhydro-salicyl-diamidobenzol; anhydro-bases and iodine; mono- and di-alkyl compounds; and the anhydro-compounds of the phenols.

On Morphine.—E. v. Gerichten and H. Schrötter.—On distilling morphine with zinc powder the authors obtained, along with pyrrol, amine bases, ammonia, pyridin, quinolin (?), also phenanthren to the extent of 3 to 4 per cent of the weight of the morphine, and 0.5 per cent of a base which they suspect to be phenanthren-quinolin.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome viii., No. 95.

Lecture on Electro-Metallurgic Procedures.—H. Bouillet.—An illustrated survey of galvano-plastic processes.

Manufacture of Commercial Aluminium Sulphate, and the Means of Ascertaining its Purity.—M. Debray.—Pure alumina for the manufacture of aluminium sulphate free from iron, is obtained as a secondary product of the treatment of cryolite (sodium aluminium fluoride) with milk of lime. The products are sodium aluminate and insoluble calcium fluoride. Deville prepared sodium aluminate by calcining bauxite (a mixture of alumina and ferric oxide) with a very caustic soda-ash. It is needful that the bauxite should be free from silica. The method used in England, *i.e.*, precipitation of the iron by potassium ferrocyanide, is practicable only where fuel and sulphuric acid are cheap. There is the further disadvantage that the Prussian blue settles slowly and retains much alumina. Persoz proposed to precipitate the ferric oxide by gelatinous alumina in excess. In this manner there is formed a basic sulphate containing very little iron. Still the purification is not absolute. A neutral aluminium sulphate has been lately sold, which does not give the characteristic precipitate of ferric salts with ferrocyanide, though far from being free from iron. It is a mixture of aluminium, zinc, and ferrous sulphates, and gives a blue precipitate with potassium ferrocyanide. If the alumina contained in such a product is precipitated with ammonia, it retains as much as 25 per cent of its weight of zinc oxide, and may thus appear to contain 15 per cent of alumina instead of 12.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. x., Part 7.

Purification of Sewage by Precipitation.—Dr. W. Wallace.—Translated from the *CHEMICAL NEWS*.

Manurial Experiments for Determining the Value of the Phosphoric Acid Soluble in Ammonium Citrate.—Dr. E. v. Wolff, Dr. J. König, and others.—The general average result is that the phosphoric acid soluble in water has been more efficient. The respective values of phosphoric acid soluble in water, precipitated and reverted, appear to be as 70, 62, and 17.

Manurial Experiments with Potassium Salts.—Prof. F. Farsky.—The action of these salts is beneficial except upon wet fields, but the result is more certain when they are accompanied with phosphoric and nitrogenous bodies. Potassium chloride was found more beneficial than the sulphate.

Value of Alpine Hay.—Dr. O. Kellner.—The albumenoid compounds in Alpine hay are more abundant than in the best hay in the low grounds, or in water-meadows, and the woody fibre is relatively less. The fatty matter is relatively plentiful, and its value is increased by the essential oils of the aromatic herbs.

Influence of Light upon Seeds.—Dr. Stebler.—The germination of many seeds of great agricultural importance is promoted by light.

A Crystalline Albumen in Pumpkin Seed.—Dr. G. Grüber.—From the *Journ. für Prakt. Chemie*.

Influence of Acids upon the Stability of Wines, and the Importance of Tannin for Red Wines.—E. Mach and K. Portele.—The authors examine the influence of tartaric, citric, malic, succinic, and acetic acids, and of tannin, upon the keeping properties of wine.

Action of the Ferment of Rennet under Various External Circumstances.—Prof. Ad. Mayer.—The author finds the presence or absence of bacteria of little moment.

Vol. x., Part 8.

Researches on the Evaporation of Free Water, of the Water present in Arable Soils, and on the Transpiration of Plants.—Felix Masure.—When the soil is very wet it throws off more watery vapour than does a sheet of free water. If moderately moist, the quantities are about equal, and if the soil is dry its evaporation is less. The transpiration of plants is a complicated phenomenon, determined partly by physical and partly by physiological conditions.

MEETINGS FOR THE WEEK.

- MONDAY, 20th.—London Institution, 5.
Medical, 8.30.
Society of Arts, 8. "Recent Advances in Photography," by Capt. W. de W. Abney, F.R.S.
- TUESDAY, 21st.—Institute of Civil Engineers, 8.
Pathological, 8.30.
Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. McKendrick.
- WEDNESDAY, 22nd.—Society of Arts, 8. "The Production and Use of Gas for Purposes of Heating and Motive Power," by J. Emerson Dowson.
Geological, 8.
- THURSDAY, 23rd.—Royal, 4.30.
Philosophical Club, 6.30.
Royal Institution, 3. "Geographical Distribution of Animals," by Dr. P. L. Sclater.
Society of Arts, 8. "Methods and Standards of Photometry," by Harold B. Dixon, M.A.
- FRIDAY, 24th.—Royal Institution, 8. "Sir E. C. Brodie's Researches on Chemical Allotropy," by Professor Odling, 9.
- SATURDAY, 25th.—Royal Institution, 3. "The Iliad and Odyssey," by W. Watkiss Lloyd.
Physical, 3. "On the Influence of the Form of Conductors on Electric Conduction Resistance," by G. Gore. "On Faure's Accumulator, and on a Simplified Form of Dispersion Photometer," by Prof. Ayrton and Perry.

THE CHEMICAL NEWS

Vol. XLV. No. 1761. 25 FEB 82

ON IMPACT WITH A LIQUID SURFACE.*

By A. M. WORTHINGTON, M.A.

THE apparatus previously used† by the author for following the progress of the splash of liquid drops impinging on a solid plate has been improved. The main principle of the method by which successive stages are isolated and rendered visible remains the same, viz., instantaneous illumination at any desired stage by means of the primary spark of an induction coil; but the timing of the illumination is now effected by a timing-sphere let fall simultaneously with the solid or liquid sphere whose impact is to be observed. The timing-sphere strikes a plate whose height can be adjusted, and thereby starts the mechanical action which results in the spark.

The time interval between successive stages of the disturbance can be measured to within a few thousandths of a second.

The significant portion of the whole series of changes in most of the splashes observed is comprised within about one-third of a second. The impact of both solid and liquid spheres has been studied, and is illustrated by several series of drawings which accompany the paper.

Milk drops falling into water were found to produce a similar disturbance to that resulting from the impact of similar water drops, and were used for the sake of distinguishing the original liquid of the drop from that into which it fell. With a drop about five millims. in diameter, falling from less than one metre, an annular rim is raised at the first moment of impact, bounding a hollow, which is afterwards characterised by regularly disposed radial ribs and arms, at the bottom of which the drop descends, passing below the surface and becoming completely submerged, to emerge again at the head of a column of adherent liquid, and with its upper portion apparently unvetted by the liquid with which it has been covered. The column then subsides, and the liquid of the original drop is seen to pass into the well-known vortex ring which descends through the liquid.

The influence of velocity of impact in modifying the phenomenon is shown by the drawings.

When the drop is large, and the fall considerable, the rim thrown up takes the form of a hollow crater-like shell of liquid, the mouth of which closes over the drop, imprisoning air which may remain as a bubble on the surface. This is the bubble seen when large rain drops fall into water. Observations of the bursting of this bubble confirm incidentally the explanation lately given by Mons. J. Plateau of the manner of bursting of a soap bubble.

The splash of a milk drop in petroleum and in olive oil is also described. The course of phenomena is very similar to that in water, modified however by the greater or less mobility of the liquids in question.

The impact of solid spheres is then described. The nature of the disturbance produced, with a given velocity of impact, is found to depend entirely on the state of the surface of the sphere.

A polished and perfectly dry sphere of ivory or marble one to three centims. in diameter, let fall from a height not exceeding one metre, is apparently wetted at once, and is seen to be sheathed with liquid before the whole is below the average level of the surface. The disturbance of the surface is very slight.

The same sphere if *rough* or *wet* with the liquid in

question, behaves quite differently, making a very deep depression, similar at first to that produced by a liquid drop, which finally becomes an almost cylindrical column of air within the liquid, part of which afterwards rises as bubbles while a portion descends in the wake of the sphere.

The influence of roughness in hindering the spread of liquid over the surface of the impinging sphere is then pointed out.

At the close of the paper an explanation is put forward of the radial ribs, arms, and striæ which are a notable feature of all splashes. Measurements of the annular rim bordering a thin central film, into which a drop falling on to a plate passes,* show that the number of the lobes and arms which are subsequently observed agrees well with the number of drops into which such an annulus would theoretically tend to split if unhindered by friction with the plate on which it rests, and it is then pointed out that the effect of the connecting film would be exactly such as to counteract the influence of this friction.

In the same way the radial striæ and ribs which characterise the hollow formed round a drop or solid sphere impinging on a liquid surface, are accounted for by the instability of the annular rim of the hollow, which through its tendency to cleave into a definite number of drops, determines a corresponding number of lines of easiest flow, at each of which a rib or arm is developed.

The author has observed that after the details have been once revealed by the method of instantaneous illumination, it is not difficult to identify the broad features of any splash that may occur by attentive observation in continuous light. Such observation may afford valuable information as to the condition of the surface of a solid,

GELATIN JELLY AS A DIALYSER.

By R. C. WOODCOCK, F.C.S., F.I.C.

JELLY prepared from gelatin has been employed by Dr. Dupré for the separation of artificial colouring matters in wines, but, so far as I am aware, its application to ordinary dialysis has never been carried out. Its use in toxicological chemistry may, however, demand some attention as the following experiments will show:—

A mixture was made of four different soups—thick and clear—about one and a half pints in all, together with boiled rice and macaroni; a little pepsin and pancreatin was added, the mixture acidulated with hydrochloric acid and digested for some time at a temperature of about 90°F. One and a half ounces of concentrated hydrochloric acid was then run in, and the mass heated nearly to boiling, when it was allowed to cool and filtered. To the filtrate 0.5 gr. of strychnine was added, and the whole diluted to 10,000 grs. 5 grs. of this mixture (=0.00025 gr. of strychnine) was diluted to 2500 grs. with water, and a gelatin cube placed in the solution, in a beaker. The jelly was prepared by making a 6 per cent solution of gelatin in hot water, allowing it to set in a suitable vessel, and then cutting a cube about 1½ inches. The solution was dialysed for sixty hours; the cube had swollen somewhat but was quite intact. The liquor was poured off, the cube well washed with distilled water, and heated in the beaker in a water-bath, and concentrated until a film of gelatin formed upon the surface of the liquid, when it was removed from the bath, cooled slightly, and strong alcohol added to about the same bulk as the liquid, a large proportion of the gelatin precipitated, and ether added until precipitation was complete. The ether and alcohol together amounted to about twice the volume of the concentrated gelatin solution. The mixture was well stirred, the gelatin adhered in a mass, so that the liquor poured off sufficiently clear without filtration. It was evaporated to dryness,

* Abstract of a Paper read before the Royal Society, February 16th, 1882.

† Proc. Roy. Soc., vol. XXV., pp. 261, 498.

* Proc. Roy. Soc., vol. XXV., p. 500, 2g. 4.

and the residue moistened with concentrated sulphuric acid, which was kept at a temperature of 140° F. for eight hours, when a little water was added, and the mass filtered from a slight charred residue. The filtrate was made alkaline with strong ammonia and extracted with chloroform. The chloroform drawn off into a porcelain basin, and carefully evaporated so as to leave the residue as little distributed as possible; a few drops of concentrated sulphuric acid was added, when it was sufficiently colourless to test for strychnine with potassium bichromate. The reaction was *distinct*. When working with solutions containing ten times this quantity of strychnine, namely, 0.0025 gr., the reaction was *most* marked.

The above method has been tried many times with various quantities of strychnine and soup extract, and it has always been found that one treatment with concentrated sulphuric acid is sufficient to carbonise the foreign organic matter, which is never present in excessive quantities, and give a residue after filtration, &c., so slightly coloured with sulphuric acid that it may at once be tested for strychnine. This is probably due to the jelly being already saturated with colloidal matter, and thus only allowing at the most traces of colloids to dialyse into it; whereas the crystalloids have free entry. With an ordinary parchment dialyser comparatively large quantities of colloids do pass through.

Rodgers and Girwood's process as generally used—carbonising with sulphuric acid, neutralising with ammonia, extracting with chloroform, &c.—has frequently to be repeated many times before the extract is obtained sufficiently clean to be tested for strychnine, and this part of the process requires much time and attention.

In the presence of large quantities of colloids the jelly does not swell so much, but the strychnine readily dialyses into it.

A 1 per cent solution of gelose gives a good firm jelly, but at present I do not think that it works so satisfactorily as gelatin.

I hope shortly to carry the investigation further—with other alkaloids, metallic substances, &c. Experiments may prove that the time used for dialysing can be considerably shortened.

ON THE ACTION OF SALT ON MOLTEN COPPER OF VARIOUS DEGREES OF "DRYNESS."

By R. MONGER.

In making some experiments with salt and copper, I always noticed that if the button of copper were broken in two, it had the appearance of tough pitch metal, whether the metal was dry or not at the commencement of the experiment. And as the change in pitch of the metal can only be accounted for by the removal of the cuprous oxide it contained, I concluded that the salt might possibly dissolve it out of the copper, and proceeded to prove the correctness or otherwise of my reasoning, and now lay before you the results of some of the experiments undertaken for that purpose:—

1. Two pieces of tough pitch Barilla copper, weighing 150 grs. each, were dropped under melted salt in a Cornish assay crucible placed in a furnace, and allowed to remain for about ten minutes, and poured into a mould, cooled and the slag detached; the both buttons lost 0.47 per cent of their original weight.

2. Two pieces of best selected copper in a moderately dry state were heated in the same manner, and lost 1.125 per cent of their weight.

3. Two pieces of very dry best selected copper treated in the same manner lost 4 per cent of their weight.

4. The two buttons from the first experiment treated in the same manner lost nothing.

All these buttons were at tough pitch, and the copper in the slag of salt can be easily obtained by mixing the slag with a little red tartar, and melting. I believe the results of these experiments go far to prove the correctness of the conclusion I came to, for the following reasons:—

1. Salt brings dry copper up to tough pitch, being just what poling does, and no doubt exists as to the pole reducing the cuprous oxide.

2. The amounts lost by the same samples of copper were identical, showing the action to be a definite one.

3. The amounts lost increase as the dryness of the copper increases, and the only difference between dry and tough pitch coppers is in the amounts of cuprous oxide they contain.

4. The buttons from the first experiment, if my conclusion be correct, would be supposed to lose nothing, having already had their cuprous oxide abstracted, and this is what the fourth experiment shows.

Taking the loss suffered by the buttons as cuprous oxide, the percentages of oxygen contained in the samples would be as follows:—

1st Expt.	=	0.052 tough pitch.
2nd "	=	0.125 rather dry.
3rd "	=	0.445 very dry.
4th "	=	none tough pitch.

I believe that this is a rapid and easy method for the estimation of cuprous oxide in copper.

Laboratory, Middle Bank Copper Works,
January 17, 1882.

ON THE BEHAVIOUR OF MANGANESE PEROXIDE AND CHLORIDE OF LIME ON IGNITION WITH CHROMIUM OXIDE AND SODIUM CARBONATE IN THE ABSENCE OF AIR.

By A. WAGNER.

SINCE manganese peroxide loses so much oxygen at a bright red heat that manganic oxide remains, the value of commercial manganese must be determinable from the proportion of oxygen lost. A direct measurement of the volume of the oxygen would, however, be attended with considerable difficulties. On the other hand, its oxidising action upon an ignited mixture of chromium oxide and sodium carbonate in the absence of air can be determined. I proceeded as follows:—In a combustion-tube, 25 c.m. long and 8 to 9 c.m. in width, were put some sodium hydro-carbonate, and then a very intimate mixture of a weighed quantity of pyrolusite (0.3 to 0.5 grm.) in very fine powder with an excess of chromium oxide and sodium carbonate, and a final stratum of the two latter ingredients only. The tube thus charged was connected by means of a cork with a small glass tube, to which again a gas-delivery tube was adapted by means of a caoutchouc tube and a screw-clip. The tube was then placed in the combustion furnace, and the above-mentioned gas-delivery tube with the clip open was made to dip into a little mercury, to exclude air. The sodium hydrocarbonate was first gently heated so as to expel air from the apparatus; then the mixture of chromic oxide and sodium carbonate at the front of the tube, and finally the stratum containing the weighed pyrolusite, was heated to redness. The full heat of the furnace was kept up for eight to ten minutes until the escape of carbonic acid from the gas-tube came to an end. The tube was then let cool, the caoutchouc pipe was closed by means of the screw clip to prevent the mercury from rising into the combustion-tube. The sodium chromate formed, which was obtained perfectly free from sodium manganate, was dissolved out from the insoluble residue, and the chromic acid was deter-

mined as chromic oxide by the ignition of mercurous chromate, according to Rose's method. The results obtained agreed fairly well with a determination of the same sample, according to the method of Fresenius and Will.

Of course if the temperature of ignition is not raised high enough, the results fall too low. The presence of lower oxides of manganese or of organic matter has also a disturbing effect.

The author does not draw any conclusion from his experiments with a single sample of chloride of lime.—*Zeitschrift. Analyt. Chemie.*

BISMUTH OXIDE AS AN AGENT FOR OPENING UP SILICATES.

By WALTHER HEMPEL.

GASTON BONG has proposed to open up silicates by fusion with lead oxide, decomposing the unstable compounds formed with nitric acid, and after eliminating the lead by means of sulphuretted hydrogen, proceeding with the analysis in the ordinary manner. This method offers great advantages, since melting lead oxide quickly decomposes the most refractory silicates, even if not in the finest state of mechanical division. In conjunction with my assistant, Dr. R. F. Koch, I have made a number of experiments with this agent, and have found it very difficult to prepare a chemically-pure lead oxide. The red lead and the litharge of commerce we found always containing silica along with other impurities. The preparation of chemically-pure lead oxide from metallic lead by dissolving it in nitric acid and igniting the nitrate thus formed, involves great mechanical difficulties, since the lead nitrate melts before decomposing, and froths strongly, so that small quantities only can be obtained in each operation. All these difficulties are overcome by substituting bismuth oxide for lead oxide, simply igniting the silicate in question with bismuth subnitrate.

This compound is easily obtained in a state of the utmost chemical purity, and it has the further advantage that it does not melt at its temperature of decomposition. The opening up can be performed in the smallest platinum crucibles, as the hyponitric acid liberated fumes slowly away and does not carry with it any of the substance. The resulting melt is dissolved in hydrochloric acid, whilst in the lead process nitric acid is required, which must be afterwards expelled.

Repeated experiments have shown that it is advisable to work with a large excess of bismuth oxide, so as to have a very basic melt, which is easily decomposed by means of hydrochloric acid. The operation succeeds easily if $\frac{1}{2}$ grm. of a silicate is heated gently with 10 grms. of bismuth subnitrate till red fumes no longer escape, and is finally kept in fusion for about ten minutes. The melt is poured as far as possible whilst still liquid into a platinum capsule floating upon cold water, and the mass thus obtained and the crucible are treated with concentrated hydrochloric acid. The solution thus obtained is evaporated to dryness for the elimination of silica; the residue is taken up with hydrochloric acid; the silica filtered off and washed with water acidulated with hydrochloric acid.

On diluting the filtrate with water the greater part of the bismuth is precipitated as oxychloride. It is filtered off, washed, and from this second filtrate the remainder of the bismuth is precipitated by means of sulphuretted hydrogen. The further treatment of the filtrate is effected in the ordinary manner.

In order to throw a light upon a possible error due to the volatilisation of the alkalis at the melting temperature of bismuth oxide, a felspar was decomposed by this method, and by the hydrofluoric process. The results were:—

W	bismuth—						
	Potassa	..	..	..	..	7.60,	7.70
	Soda	..	..	..	..	4.71,	4.72
With	hydrofluoric acid—						
	Potassa	..	..	..	..	7.86,	7.77
	Soda	..	..	..	..	4.70,	4.84

The operation can be safely conducted in a platinum crucible if care be taken that it is not in a reducing atmosphere. If reducing gases are present, metallic bismuth is formed, which destroys the crucible. Silicates which contain organic matter must first be ignited with access of air. A number of meltings have been performed in the same crucible, which suffered no injury.

As bismuth is a costly metal it is prudent to work up all the precipitates into subnitrate. This may be conveniently done by melting the residues and the filters along with soda in a Hessian crucible, dissolved in nitric acid the metallic bismuth thus obtained and precipitating the solution with water as a basic nitrate.

Finally I must recommend that the decomposition of silicates should be effected under a draught-hood, as the bismuth oxide volatilises slightly at the melting-point, and the vapours seem to be very poisonous.—*Zeitschrift für Analyt. Chemie.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY
SAMPLES OF THE WATER SUPPLIED TO LONDON,
FOR THE MONTH ENDING JANUARY 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE
LOCAL GOVERNMENT BOARD.

February 5th, 1882.

SIR,—We submit herewith the results of our analyses of the 175 samples of water collected by us during the month of January on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 175 samples, three only were recorded as "very slightly turbid." The remaining 172 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from January 2nd to January 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 25 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the Lambeth Water Company, one was recorded as "very slightly turbid," the remaining 24 being well filtered, clear, and bright.

Of the 25 samples from the mains of the Grand Junction Company, the whole excepting one which was "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 25 samples from the mains of the Southwark and Vauxhall Company, the whole excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It is observable that the gradual increase which began in the month of October, both in the proportion of organic carbon and the degree of brown tint, reached its maximum in the month of December, since when there has been a return in these particulars towards the more usual condition of the water.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

CELESTIAL CHEMISTRY FROM THE TIME OF NEWTON.*

By T. STERRY HUNT, LL.D., F.R.S.

(Concluded from p. 76.)

IF now we look to the third book of the "Principia," we shall find in proposition 41 the remarkable chemical argument by which Newton was led to regard the interstellar ether as affording "the material principle of life" and "the food of planets." Considering the exhalations from the tails of comets, he supposes that the vapours thus derived, being rarefied, dilated, and spread through the whole heavens, are by gravity brought within the atmospheres of the planets, where they serve for the support of vegetable life. Inasmuch, moreover, as all vegetation is supported by fluids, and subsequently by decay is, in part, changed into solids, by which the mass of the earth is augmented, he concludes that if these essential matters were not supplied from some external source they must continually decrease, and at last fail. This vital and subtle part of our atmosphere, so important, though small in amount, he then supposed might come from the tails of comets.†

This appeared in the first edition of the "Principia," in 1687. It was not until later that the conception of exhalations from other celestial bodies took shape in the mind of Newton, as we may learn from the "Optics." Thus, in the first edition of this work, in Query 11, the sun and fixed stars are spoken of as great earths, intensely heated, and surrounded with dense atmospheres which, by their

weight, condense the exhalations arising from these hot bodies. To this Query is added, in 1706, the suggestion that the weight of such an atmosphere "may hinder the globe of the sun from being diminished except by the emission of light;" while in the second English edition, in 1718, we find a further addition, in the words "and a very small quantity of vapours and exhalations." A similar change of view appears in the query now numbered 28, wherein we read of "places [almost] destitute of matter," and also that "the sun and planets gravitate towards each other without [dense] matter between." In these quotations the two words in brackets are wanting in the edition of 1706, and first appear in that of 1718; while the language which we have in a previous page quoted from this same Query is found in the edition of 1706.

The Queries now numbered 17-24 appeared for the first time in the edition of 1718, and herein we find, in 18, the ethereal medium spoken of as being "by its elastic force expanded through all the heavens." Of this medium, "which fills all space adequately," he asks, "may not its resistance be so small as to be inconsiderable," and scarcely to make any sensible alteration in the movements of the planets? This complex ether of the interstellar space was thus, in the opinion of Newton, made up in part of matter common to the planetary and stellar atmospheres, the origin and importance of which is concisely stated in the paragraph which appears for the first time in 1713, in the second edition of the "Principia," in the third book, at the end of proposition 42, here much augmented. In this statement, which serves to supplement and complete that already made in 1687, in proposition 41, we read that the vapours which arise alike from the sun, the fixed stars, and the tails of comets, may by gravity fall into the atmospheres of the planets, and there be condensed, and pass into the form of salts, sulphurs (i. e., combustible matters), tinctures, clay, sand, coral and other terrestrial substances.†

The conception of Newton, who—while rejecting alike the plenum of the Cartesians, with its vortices and an absolute vacuum—imagined space to be filled with an exceedingly attenuated matter, through which a free circulation of gaseous substances might take place between distant worlds, has found favour among modern thinkers, who seem to have been ignorant of his views. Sir William Grove, in 1842, suggested that the medium of light and heat may be "a universally diffused matter; and subsequently, in 1843, in the chapter on Light in his "Essay on the Correlation of Physical Forces," concluded with regard to the atmospheres of the sun and the planets, that there is no reason "why these atmospheres should not be, with reference to each other, in a state of equilibrium. Ether, which term we may apply to the highly attenuated matter existing in the interplanetary spaces, being an expansion of some or all of these atmospheres, or of the more volatile portions of them, would thus furnish matter for the transmission of the modes of motion which we call light, heat, &c.; and possibly minute portions of the atmospheres may, by gradual accretions and subtractions, pass from planet to planet, forming a link of material communication between the distant monads of the universe. Subsequently, in his address as President of the British Association for the Advancement of Science, in 1866, Grove further suggested that this diffused matter may become a source of solar heat, "inasmuch as the sun may condense gaseous matter as it travels in space, and so heat may be produced."

Humboldt, also, in his "Cosmos," considers the existence of a resisting medium in space, and says "of this impeding ethereal and cosmical matter," it may be supposed

* Read before the Cambridge Philosophical Society, November 28, 1881, and reprinted from its *Proceedings*.

† "Vapor enim in spatiis illis liberrimis perpetuo rarescit, ac dilatatur. Quæ ratione fit ut cauda omnis ad extremitatem superiorem latior sit quam juxta capita cometæ. Ea autem rarefactione vaporem perpetuo dilatatum diffundi tandem et spargi per coelos universos, deinde paulatim in planetas per gravitatem suam attrahi et cum eorum atmosphaeris misceri, ritiori consentaneum videtur. Nam quemadmodum maria ad constitutionem Terræ hujus omnino requiruntur, idque ut ex iis per calorem Solis vapores copiosè satis excitentur, qui vel in nubes coacti decidunt in pluvias, et Terram omnem ad procreationem vegetabilium irrigent et nutriant; vel in frigidis montium verticibus condensati (ut aliqui cum ratione philosophantur) decurrant in fontes et flumina: sic ad conservationem marium et humorum in planetis requiri videntur cometæ, ex quorum exhalationibus et vaporibus condensatis, quicquid liquoris per vegetationem et putrefactionem consumitur et in Terram aridam convertitur, continuo suppleri et refici possit. Nam vegetabilia omnia ex liquoribus omnino crescent, dein magnâ ex parte in Terram aridam per putrefactionem abeunt, et limus ex liquoribus putrefactis perpetuo decedit. Hinc moles Terræ aridæ indies augetur, et liquores, nisi aliunde augmentum sumerent, perpetuo decrescere deberent, ac tandem deficere. Porro suspicor spiritum illum, qui særis nostri pars minima est, sed subtilissimam et optimam, et ad rerum omnium vitam requiritur, ex cometis præcipue venire."—Newton, "Principia," lib. III., prop. xli.

* Compare this with Prop. x., Book III. of the "Principia."

† "Vapores autem, qui ex Sole et stellis fixis et caudis cometarum oriuntur, incidere possunt per gravitatem suam in atmosphaeras planetarum, e, ibi condensari et converti in aquam et spiritus humidos et subinde per lentem calorem in sales, et sulphura, et tincturas, et limum, et lutem, et argillam, et arenam, et corallia, et substantias a ias terrestres paulatim migrare."—Newton, "Principia," lib. III., prop.

that it is in motion, that it gravitates, notwithstanding its great tenuity, that it is condensed in the vicinity of the great mass of the sun, and that it may include exhalations from comets; in which connection he quotes from the 42nd proposition of the third book of the "Principia." He further speaks comprehensively of the "vaporuous matter of the incommensurable regions of space, whether, scattered without definite limits, it exists as a cosmical ether, or is condensed in nebulous masses and becomes comprised among the agglomerated bodies of the universe."⁶ Humboldt also cites in this connection a suggestion made by Arago in the "Annuaire du Bureau des Longitudes" for 1842, as to the possibility of determining, by a comparison of its refractive power with that of terrestrial gases, the density of "the extremely rare matter occupying the regions of space."[†]

In 1854 Sir William Thomson published his note "On the Possible Density of the Luminiferous Ether,"[‡] wherein he remarks "that there must be a medium of material communication throughout space to the remotest visible body is a fundamental conception of the undulatory theory of light. Whether or no this medium is (as appears to me most probable) a continuation of our own atmosphere, its existence cannot be questioned." He then attempts to fix an inferior limit to the density of the luminiferous medium in interplanetary space by considering the mechanical value of sunlight, as deduced from the value of solar radiation and the mechanical equivalent of the thermal unit. He concludes "that the luminiferous medium is enormously denser than the continuation of the terrestrial atmosphere would be in interplanetary space if rarefied according to Boyle's law always, and if the earth were at rest in a state of constant temperature, with an atmosphere of the actual density at its surface." The earth itself in moving through space "cannot displace less than 250 pounds of matter."

In 1870 W. Mattieu Williams published his very ingenious work entitled "The Fuel of the Sun," in which, apparently without any knowledge of what had been written before with regard to an interstellar medium, he attempts to find therein the source of solar heat—the "solar fuel" of Newton. To quote his own language—"The gaseous ocean in which we are immersed is but a portion of the infinite atmosphere that fills the whole solidity of space, that links together all the elements of the universe, and diffuses among them light and heat, and all the other physical and vital forces which heat and light are capable of generating" (*loc. cit.*, p. 5).

Since the days of Newton, however, no one had hitherto considered the interstellar matter from a chemical point of view. In 1874, as already shown, the writer had, in extension of the conception of Humboldt that his condensation gives rise to nebulae, ventured the suggestion that from an ethereal medium having the same composition as our own atmosphere, the chemical elements of the sun and the planets have been evolved, in accordance with the views of Brodie, Clarke, and Lockyer, by a stoichiogenic process; so that in the language of Newton's Hypothesis, "all things may be originated from ether."

It was not, however, until 1878 that, from a consideration of the chemical processes which have gone on at the earth's surface within recorded geological time, I was led to another step in this enquiry. That all the de-oxidised carbon found in the earth's crust in the forms of coal and graphite, as well as that existing in a diffused state, as bituminous or carbonaceous matter, has come, through vegetation, from atmospheric carbonic acid, appears certain. To the same source we must ascribe the carbonic acid of all the limestones which, since the dawn of life on our earth, have been deposited from its waters. It is through the sub-aerial decay of crystalline silicated rocks, and the direct formation of carbonate of lime, or of car-

bonate of magnesia and alkalies which have reacted on the calcium salts of the primæval ocean, that all limestones and dolomites have been generated. These, apart from the coaly matter, hold, locked up and withdrawn from the aerial circulation, an amount of carbonic acid which may be probably estimated at not less than 200 atmospheres equal in weight to our own. That this amount, or even a thousandth part of it, could have existed at any one time in our terrestrial atmosphere since the beginning of life on our planet is inconceivable, and that it could be supplied from the earth's interior is an hypothesis equally untenable.

I was therefore led to admit for it an extra-terrestrial source, and to maintain that the carbonic acid has thence gradually come into our atmosphere to supply the deficiencies created by chemical processes at the earth's surface. Since similar processes are even now removing from our atmosphere this indispensable element, and fixing it in solid forms, it follows that except volcanic agency, which can only restore a portion of what was primarily derived from the atmosphere, there are on earth, besides organic decay, only the artificial processes of human industry which can furnish carbonic acid; so that but for a supply of this gas from the interstellar spaces now, as in the past, vegetation, and consequently animal life itself, would fail and perish from the earth for want of this "food of planets."

Such were the conclusions, based on an induction from the facts of modern chemistry and geology, which I enunciated in my papers in 1878 and 1880, already quoted in the first part of this essay. I was at that time unacquainted with the Hypothesis of Newton, and with his remarkable reasoning contained in the 41st proposition of the third book of the "Principia," in which he, so far as was possible with the chemical knowledge of his time, anticipated my own argument, and showed how and in what manner the interstellar ether may really afford the "food of planets," and, in a sense, "the material principle of life."

I have thus endeavoured to bring before the Philosophical Society of Cambridge a brief history of the development of this conception of an interstellar medium, and to show that the thought of two centuries has done little more than confirm the almost forgotten views of Newton. It is with feelings of peculiar gratification that I have been able to indite these pages within the very walls of the college in which our great philosopher lived and laboured, and where, combining all the science of his time with a foresight which seems well-nigh divine, he was enabled, in the words of the poet, "to think again the great thought of the creation."

Alkali, &c., Works Regulation Act, 1881.—The following circular has been sent by the Secretary of the Local Government Board to the owner, lessee, occupier, or other person carrying on any work to which the Alkali, &c., Works Regulation Act, 1881, applies:—Sir,—I am directed by the Local Government Board to refer to their Circular of the 31st of December last, in which they drew your attention to the requirements of the Alkali, &c., Works Regulation Act, 1881, with respect to the registration of the several kinds of Works to which the Act applies. I am directed to remind you that, under Subsection (3) of Section 11 of the Act, application for Certificates of Registration is required to be made in the month of January or February in every year; and that, under Subsection (6), the owner of any work which is carried on after the 1st day of April, 1882, without being registered, exposes himself to a penalty not exceeding Five Pounds for every day during which it is so carried on. If, therefore, your Works come within the Act, it is necessary that an application for a Certificate of Registration in respect of them should be made to the Board in the prescribed form, of which a copy is enclosed, *without any further delay*.—I am, Sir, your obedient servant, JOHN LAMBERT, Secretary.

⁶ "Cosmos," Otté's translation, Harper's ed., vol. i., pp. 82, 86.

[†] *Ibid.*, vol. iii., p. 40.

[‡] *Trans. Roy. Soc. Edinburgh*, vol. xxi., part I.; and *Ph Mag.*, 1855, vol. ix., p. 36.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 16, 1882.

Prof. H. E. Roscoe, President, in the Chair.

DURING the evening a ballot was held, Dr. Hodgkinson and Mr. Kingzett being appointed scrutineers. The following gentlemen were declared duly elected:—H. J. Alford, H. L. Buckeridge, A. Blaikie, J. J. Beringer, W. E. Bush, G. W. Davies, J. F. Heyes, W. Hamilton, T. Isherwood, H. H. Philipps, T. Pitt, H. Porter, G. McRobert, C. H. Ridsdale, V. O. Sells, L. T. Thorne, S. Young. The following certificates were read for the first time:—J. Brown, H. H. Crawley, U. K. Dutt, T. Donnelly, R. Mar, J. T. Smith.

During the evening the Chairman mentioned that the Council had proposed the following changes in the Officers of the Society for the ensuing year:—Dr. Gilbert, President; Dr. Schunck and Mr. P. Griess as Vice-Presidents; Drs. Atkinson and Japp, Capt. Abney, and Mr. O'Sullivan as Ordinary Members of the Council instead of Dr. Tidy and Messrs. Carteighe, Roberts, and Warrington.

The following papers were read:—

"On Benzyl Phenol and its Derivatives (Part II.)," by E. H. RENNIE. In a previous paper the author suggested that from the great resemblance between the reactions exhibited by para-cresol and benzyl-phenol, the latter belongs to the para series of compounds. The present investigation has fully confirmed this view. The author has prepared and studied the following derivatives:—Benzyl-phenol-sulphonic Acid—On account of the unstable nature and great solubility of this substance it was found impossible to obtain it pure. Mono-nitro-benzyl-phenol was obtained in golden-yellow prisms melting at 74° to 75°. Its potassium salt is deep red when dried at 100°. Amidobenzyl-phenol; Dinitro-benzyl-phenol, melting at 87° to 88°. Its potassium salt is orange. By the action of concentrated nitric acid on this substance, trinitro-benzyl-phenol is obtained. The author then studied the oxidation of trinitro-benzyl-phenol with chromic liquor, &c. By the action of nitric acid on nitro-bromo-benzyl-phenol, ortho-brom-dinitro-phenol was obtained, instead of trinitro-benzyl-phenol. When nitric acid acts on potassium bromo-sulphonate, the same nitro-bromo-derivative is obtained as when bromine acts on the potassium nitro-sulphonate. The formulæ of the bromo-sulphonate and of the nitro-sulphonate must therefore be symmetrical. This can only be the case if benzyl-phenol is a para derivative. Other considerations point to the same result, and, in addition, the author has been able to furnish a direct proof that benzyl-phenol is a para derivative. By the oxidation of benzyl-phenyl-methyl-ether with alkaline permanganate a neutral substance is obtained, melting at 61° to 62°. This body has the composition of methoxybenzo-phenon. Now Grucarevic, and Merz and Doeblner have shown that by treating phenol with two molecules of benzoyl chloride and some zinc chloride a benzoyl-phenylbenzoate was obtained, which, on saponification, yielded potassium benzoate and para-oxybenzo-phenon. Now if benzyl-phenol be a para-derivative, the methyl-ether of para-oxybenzo-phenon must be identical with the body produced by the oxidation of benzyl-phenyl-methyl-ether. The author therefore prepared some para-oxybenzo-phenon, melting at 134°, and converted it into the methyl-ethyl by KHO and MeI, &c., and found this methyl-ether to be identical with the substance mentioned above in every respect, melting at 61° to 62°, &c. The two substances being identical, benzyl-phenol must be a para-derivative.

"On the Chemical Examination of the Buxton Thermal Water," by J. C. THRESH. In a previous paper the author communicated the results of an examination of the sinter

deposited by the above water, and in the present paper completes the examination of the spring by a most elaborate analysis of the saline constituents of the water. The flow per minute is not less than 101 gallons. The density of the water is 0.99992. Full details are given as to the methods employed in the analysis. The final result may be tabulated as follows:—

	Parts in 10,000 Water.
Calcium bicarbonate..	2.0014
Magnesium carbonate ..	0.8587
Ferrous carbonate ..	0.0044
Manganous carbonate ..	0.0040
Barium sulphate ..	0.0069
Calcium sulphate ..	0.0373
Potassium sulphate ..	0.0888
Sodium sulphate ..	0.1205
Lead sulphate ..	0.0006
Sodium nitrate ..	0.0037
Calcium fluoride ..	0.0028
Sodium chloride ..	0.4412
Ammonium chloride..	0.0003
Magnesium chloride..	0.1361
Silicic acid ..	0.1356
Lithium ..	trace
Strontium ..	trace
Phosphoric acid ..	trace
Organic matter ..	0.0033
Free CO ₂ ..	0.0287
Free nitrogen ..	0.0272
Total ..	3.9015

The author also quotes the analyses of previous observers.

"On Retrograde Phosphates," by F. J. LLOYD. It has long been known that in some superphosphates the percentage of soluble phosphate originally present gradually decreases. The phosphate which has thus become insoluble in water is termed retrograde phosphate. Two questions are connected with this change—What is the exact composition of these retrograde phosphates? and can retrograde phosphates be estimated? The author has directed his attention almost entirely to answering the second question. He gives a *resumé* of the subject up to the present time. The author first investigates the solvent action of an alkaline, a neutral, and an acid solution of ammonium citrate on ground coprolites, bone-ash, and precipitated phosphates. He finds that while coprolites, bone-ash, and bone-meal are less soluble in an ammoniacal solution than in a neutral solution, precipitated phosphates are more soluble in the alkaline solution. The author next directed his attention to the effects produced by the quantity of citric acid and by the quantity of ammonia present on the solubility of the above substances. 20, 30, and 40 per cent solutions of citric acid were used, and the quantity of ammonia present was varied, so that in one case an excess of ammonia was present sufficient to neutralise one-fourth of the citric acid, and in the other an excess equal to one-half the citric acid. The author concludes that an ammoniacal solution of ammonium citrate, whatever its strength, does not act upon mineral phosphates or bone-ash, but is capable of dissolving precipitated calcium phosphate. The next question was to decide whether these ammoniacal solutions act upon the retrograde phosphates. After many experiments with the methods of Fresenius, Petermann, Joulie, &c., the author found that the most accurate results were obtained by extracting 1 grm. of the phosphate with 50 c.c. of a cold ammoniacal solution of ammonium citrate containing 30 or 40 per cent of citric acid, and that the error, whatever it may be, consists, not in finding more retrograde phosphate than actually exists, but in not finding all that is present.

"Contributions to our Knowledge of the Composition of Alloys and Metal Work, for the most part Ancient," by W. FLIGHT. This paper consists of a series of analyses of various ancient coins, &c. (1) Facts relating to the

History of Copper-nickel Coinage. The author has analysed some old Baſſian coins, about 230 B.C. They contain about 77 per cent of copper, 20 per cent nickel, with cobalt and iron in smaller quantities. (2) Some curious Square Coins of Ancient India 500 B.C. were examined. These contained 89 per cent silver, 4 per cent copper, 4 per cent lead, with silver chloride, gold, and graphite. (3) A Figure of Buddha contained 57 per cent Ag, 4 per cent AgCl, 37 per cent Cu, with gold and graphite. (4) Bidrai Ware, India, from Secunderabad. This consists of boxes, or bottles, or bowls of an alloy containing 94 per cent Zn, 4 per cent Cu, 1.5 per cent Pb, into the surface of which thin sheet-silver is inlaid. (5) Koft Gari Work from the Punjāb, near Cashmere. The groundwork consists of iron blued by heat, and with a design of gold and silver. (6) A Sickle found at the foot of a Sphinx at Karnak. Its composition was—SiO₂, 11.9 per cent; Fe₃O₄, 5.1; CaCO₃, 0.1; Fe₂O₃, 64.6; water, 18.2; nickel, trace. This was supposed to be one of the oldest pieces of iron in existence. (7) Piece of Iron found in the Air Passages of the Great Pyramid. The interest of these two specimens of old iron is that from their analyses they appear not to be of meteoric origin, but to have been manufactured. (8) Double Hook of Bronze found in an Air Passage of the Great Pyramid. It contained 99.5 per cent Cu. (9) Bronze Figures brought from Egypt by Mr. John Dixon, supposed to be of Ptolemaic origin. A figure of Isis contained 68.4 per cent Cu, 4.7 per cent Fe, 22.7 per cent Pb, 1.5 As, traces Ni and Sb, and 0.9 per cent Sn. Another bronze contained 82.2 per cent Cu, 15.8 per cent Pb, 2.0 per cent Sn. (10) Copper Spear-heads from Cyprus contained Cu 97 to 99 per cent, Fe 0.4 to 1.3 per cent, As trace to 1.3 per cent, &c. (11) Copper Axe-heads from near Bethlehem contained 99.5 per cent Cu. (12) Hebrew Shekel, weighed 14.27 grms., contained 97.6 per cent Ag, 0.6 per cent Au, 0.6 per cent Cu. (13) Various Cypriote, Roman, and Greek Bronzes contained 78 to 87 per cent Cu, 8.5 to 10.9 per cent Sn, 1.5 to 9 per cent Pb. (14) Inca's Pin from a Mummy at Arica, 82 per cent Ag, 1.4 per cent AgCl, 16.1 Cu. (15) Bronze Bar from Temple in Bolivia, Cu 93.2 per cent, Sn 6.5 per cent.

"On the Dissociation of Chlorine," by A. P. SMITH and W. B. LOWE. In 1879 Meyer showed that the vapour-density of chlorine at 1200° to 1500° was two-thirds of its vapour-density at 600°. It occurred to one of the authors that if chlorine was passed through a tube into potassium iodide less iodine might be liberated when the tube was heated than when cold. The authors have tested this point, and conclude that less iodine is liberated by chlorine after heating to 1030° than by chlorine which has not been so heated; or, to use their own phraseology, 1 grm. of chlorine at 6° becomes 0.744 grm. Cl at 1030°. What becomes of the rest is not stated.

The Society then adjourned to March 2, when the following papers will be read:—"On the Luminous Incomplete Combustion of Ether and other bodies at Temperatures below Redness," by W. H. PERKIN; "On the Action of Aldehyd on Phenanthraquinon in Presence of Ammonia," by F. R. JAPP and F. W. STREATFIELD; "On the Application of the Aldehyd and Ammonia Reaction in Determining the Constitution of Quinon," by F. R. JAPP and F. W. STREATFIELD.

THE METEOROLOGICAL SOCIETY.

Monthly Meeting, Wednesday, February 15, 1882.

Mr. J. K. LAUGHTON, M.A., F.R.A.S., President, in the Chair.

The following gentlemen were balloted for and duly elected Fellows of the Society:—W. AVONSBURG, J.P.; W. G. BIRCHBY; J. RAND CAPRON, F.R.A.S.; P. CROWLEY, F.Z.S.; W. W. CULCETH, M. Inst. C.E.; D. CUNNINGHAM,

M. Inst. C.E., F.S.S.; S. CUSHING; W. N. GREENWOOD E. KITTO; J. MANSERGH, M. Inst. C.E.; G. OLIVER, M.D.; H. S. H. SHAW, Assoc. M. Inst. C.E.; G. W. STEVENSON; M. Inst. C.E., F.G.S.; and W. H. TYNDALL.

The Papers read were:—

"Notes of Experiments on the Distribution of Pressure upon Flat Surfaces Perpendicularly Exposed to the Wind," by C. BURTON, B.A., F.R.A.S., and R. H. CURTIS, F.M.S. In the present state of aëro-dynamics it seems to be impossible to make an *à priori* investigation of the distribution of pressure on a surface exposed to the impact of the fluid in motion without introducing such limitations as render the solutions arrived at widely divergent from the results obtained by the experiments hitherto made. The authors therefore proposed to themselves to attack the problem from the experimental side: only by a method which, as far as they know, has not been applied in the case of air, viz., the application of Pitot's tube, suitably modified in form, to the simultaneous measurement of the pressures at the centre and at any excentrically situated point of a pressure plate of known dimensions. The results of the preliminary experiments are given in the present paper.

"The Principle of New Zealand Weather Forecasts," by Commander R. A. EDWIN, R.N., F.M.S.

"The High Atmospheric Pressure of the Middle of January, 1882," by H. SOWERBY WALLIS, F.M.S.

The Electrical Thermometer lent by Messrs. Siemens Bros. for observing the temperature of the air at the summit of Boston Church tower was also exhibited.

CORRESPONDENCE.

RETROGRADE PHOSPHATES.

To the Editor of the Chemical News.

SIR,—With respect to Mr. Lloyd's paper on "Retrograde Phosphates," read last evening before the Chemical Society, I would draw attention to the unfairness of the manner in which the ammonium citrate is now generally employed on the Continent. The habit now usually—or, to say the least very frequently—is to specify a superphosphate as containing so much "soluble," so much "assimilable," and so much "insoluble." Now that portion characterised by the second of these terms, "assimilable," is estimated by means of a solution of ammonium citrate (say Joulie's), and is that portion of the phosphate which, though insoluble in water, is taken up by the ammonium citrate. Many Continental, and more particularly French, agricultural chemists assert this portion of the phosphate to be "assimilable," and state it as such in their analyses. Such may be the case, and it is even, I may say, probable that if the choice is to lie between two portions of tricalcic phosphate,—one of them soluble in neutral ammonium citrate, the other insoluble—the former would be found more easily assimilable than the latter; but the use of the word "assimilable" as applied to such soluble phosphate assumes this unfairly, and the expression has a pernicious tendency to mislead the public. Not only this, however. The ammonium citrate solution is even a better solvent for both aluminium and ferric phosphates than it is for calcic phosphate, and these which are, we may say, constantly present in large proportion in retrograde phosphates are taken into solution by the citrate even more readily than the calcic phosphate is; so that these phosphates—whose utility from an agricultural point of view has been contested by many, or denied entirely by some—are by this mode of treatment classed as "assimilable." If the general use of the ammonium citrate is to be accepted in this country, and I see no reason why it should not, affording as it does *some* distinction as to the solubility, and possibly the more ready assimilability, of those more insoluble portions of artificial manures—let those por-

tions of phosphate estimated by it be characterised simply as "soluble in ammonium citrate," and in no other manner, and let the misleading expression "assimilable" be once for all discarded. The farmer will soon learn by practical experience what is the agricultural value of the ammonium citrate test, and doubtless that part of a manure estimated by it will not fail to find its proper value in the market; but at least he will not have been victimised by a delusive misnomer. I believe I am right in stating that this ammonium citrate test is the invention of a large French manure manufacturer, and one can well understand this to be the case, seeing how favourable its indications are to the manufacturers' interests rather than to those of the farmer.—I am, &c.,

F. MAXWELL LYTE.

Science Club, 4, Savile Row,
February 17, 1882.

SACCHARIMETRY.

To the Editor of the Chemical News.

SIR,—There seems to me to exist a widespread misapprehension regarding the limits for the rational use of Clerget's method for correcting the readings of the optical saccharimeter, and an expression of dissent from my views on the subject, in your recent review of a book on sugar analysis, of which I am author, is the occasion of this communication, in which, with all deference to the reviewer, I desire to amplify the matter somewhat. The passage referred to in the above work, in mentioning Clerget's method, is as follows:—"It must be remembered that the process is entirely inapplicable when any optically-active body is present besides cane or invert sugar, and also if the invert sugar itself exists in an inactive condition as regards polarised light."

The process has been recommended directly or implicitly in many of the books and journals for the correction of the error caused by optically-active impurities in general, and one author has even employed it for sugars containing large proportions of commercial grape sugars, notwithstanding that this substance is dextrogyrate at all temperatures, and generally contains much dextrin and soluble starch with a dextro-rotation of about three times that of dextrose.

It appears to me that it is only necessary to refer to the experimental basis of the method to make perfectly clear the fact that the formula derived therefrom, and from which the table is calculated, admits and takes into account only the disturbing action of invert sugar of the variety produced by acids on cane sugar of known rotatory power at given temperatures; consequently any other body present, either before or after inversion, of a different optical power from the cane or invert sugars, or which acquires such property through inversion, will alter the legitimate conclusion which the method is adapted to give. Clerget (*Ann. Phys. Chim.* [3], xxvi., 175; *Ann. Chem. Pharm.*, lxxii., 145) found that cane sugar reading +100° on the saccharimeter if submitted to complete inversion by acids, showed -44°, making a difference of 144°. He also found that the rotation of the inverted sugar, unlike that of cane sugar, varied with the temperature, and to such an extent that, very approximately, for every degree Centigrade the temperature was raised, the rotation sank 0.5°, so that at 0° C. the action is expressed by $T = 144 - \frac{1}{2}t$. If S represents the sum or difference of the readings before and after inversion, t the temperature of the inverted solution when tested, and R the corrected percentage of cane sugar, then—

$$144 - \frac{1}{2}t : 100 :: S : R,$$

whence—

$$R = \frac{200S}{288 - t},$$

from which formula the table was calculated.

The whole process thus stands strictly upon Clerget's experiment in which only two rotatory bodies have any

part, and the readings must be the resultant of the specific rotatory powers of these sugars and *nothing else*. The following is a list of some of the substances that may exist in a saccharine material to be tested, with the approximate specific rotatory powers; there are many more known to be optically active, but which have been little studied in this respect. If it is allowed that the above formula is based only on the optical properties of cane and invert sugar, it is hard to see how a mixture containing in addition one or all of the succeeding bodies, with rotative powers, not only varying largely, but also different in acid, neutral or alkaline solution, could give results at all agreeing with what should be expected from cane and invert sugar alone:—

Cane sugar	$[\alpha]_D^{20}$ 73.8
Dextrose	" 52.5
Invert sugar (gen. formula) ..	$[\alpha]_D^{20} t = (27.9 - 0.32 t)$
Tuchschmid.	
Maltose	$[\alpha]_D^{20} = 139.3$
Dextrin	$[\alpha]_D^{20} = 212$ to 139
Beet gum	Strongly to the left
Soluble starch	" "
Glutaminic acid	$[\alpha]_D^{20} = 34.7$
Albumen	" = -35.5
Aspariginic acid	$[\alpha]_D^{20}$ acid 25.16
	alkaline NaOH -2.22
	" NH_4O -11.67
Asparigine	$[\alpha]_D^{20}$ acid 35.09
	alkaline -7.50
	" neutral -6.23

A fact showing the unreliability of the process in many cases, and deduced from my own experience and the published results of others, is that the corrected percentage of cane sugar is often lower than the first reading, while theoretically the reverse should be the case, as invert sugar at all ordinary temperatures possesses a laevo-rotation, making the first reading too low.

Landolt,* a high authority on such subjects, states distinctly that the results given by Clerget's method are unreliable when optically-active bodies other than invert sugar are present, and that in beet-sugar syrups organic acids are set free on inversion, which turn the polarised ray partly to the right and partly to the left.

The inapplicability of the method when only inactive invert sugar exists in the solution consists in its being unnecessary.—I am, &c.,

J. H. TUCKER.

Philadelphia.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 4, January 23, 1882.

Explosive Wave.—M. Berthelot.—The author holds that his recent experiments on the propagation of explosive phenomena in gases reveal the existence of a new kind of undulatory movements of a mixed order, produced by a certain concordance of physical and of chemical impulses within matter which is undergoing transformation. The speed of the explosive wave is totally different from that of sound-waves propagated in the same medium.

Spectroscopic Observations by Mono-chromatic Light.—C. V. Zenger.—The author has shown the power of dispersion presented by combining in a parallelepipedon

* "Optische Drehungsvermögen," p. 181; *Journ. Prakt. Chem.*, ciii., p. 22.

two prisms having very different indices for red and violet light, and equal indices for light of mean refrangibility. He finds that among the liquids which furnish at once a sufficiently powerful dispersion, a perfect transparency, and the total reflection of the red and the violet part, benzol and benzylene, combined with quartz, eliminate the extreme red, whilst pure anethol eliminates the extreme violet.

Remarks on the Note of MM. Mignon and Rouart on Processes of Coppering.—F. Weil.—The author endeavours to show that his system differs less from that of MM. Mignon and Rouart than their letter of Jan. 9th would seem to imply.

Determination of the Nodes in Columns of Vibrating Air by means of the Microphone.—J. Serra-Carpi.—Not suitable for abstraction.

No. 5, January 30, 1882.

Combination of Carbonic Acid with Water.—S. Wroblewski.—Whilst examining the solubility of carbonic acid in water under high pressures, the author has found evidence of the existence of a hydrate of carbonic acid, easily dissociable and capable of being formed by pressure, like Ogier's hydrochlorate of hydrogen phosphide. This hydrate probably contains equal volumes of carbonic gas and of watery vapour, but this point is not yet directly established.

Silico-molybdic Acid.—F. Parmentier.—The author has isolated silico-molybdic acid, perfectly crystallised, in the shape of yellow cubo-octahedra, without action upon polarised light. They melt about 45° in their water of crystallisation, and are decomposed below 100°. The acid is very soluble in water and in dilute acids, and forms crystalline salts with bases. Alkaline carbonates and ammonia in excess decompose it with a precipitation of silica. Silico-molybdic acid resembles phospho-molybdic acid in colour and crystalline form. But it is less stable. Ammonium phospho-molybdate is insoluble, whilst silico-molybdic acid gives no precipitate with ammoniacal salts, save in very concentrated solutions. Phospho-molybdic acid gives an insoluble compound with potassa, whilst silico-molybdic acid gives no precipitate, even in the most concentrated solutions of potassium salts. Salts of caesium and rubidium, even when present in small quantity along with other alkaline salts, may be detected by means of silico-molybdic acid. The rubidium silico-molybdate is slightly soluble, whilst the corresponding caesium salt is totally insoluble, by which means the two may be separated.

New Combinations of Aldehyds with Phosphonium Iodide.—J. de Girard.—By the action of propylic acetal upon phosphonium iodide the author obtains a compound, $(C_3H_7O)_4PH_4I$. He has ascertained that the propionic, salicylic, and benzoic aldehyds yield, on contact with phosphonium iodide, compounds of the same order.

Vapour-Density of Sulphuryl Perchloride.—J. Ogier.—The author concludes from his results that the true gaseous density of pyro-sulphuryl chloride, not dissociated, below 200°, is equal to 3.72. The weight of a litre is therefore 4.809 grms., or for 22.32 litres 107.5 grms. The double formula, $S_2O_3Cl_2 = 215$ grms., to which the atomic weight O = 16 leads, cannot be admitted, except we assume at the same time that the gaseous molecule may occupy 8 volumes of vapour.

Formation of an Aldehyd-Aceton and of a Glycol of the Aromatic Series.—E. Burcker.—The new aldehyd-aceton is a faintly yellowish liquid of a pleasant odour and a burning taste. It boils at 235°, and is decomposed at a somewhat higher temperature. It is easily soluble in alcohol, ether, chloroform, and benzol, and is insoluble in water. It reduces the solution of silver nitrate, but does not combine with alkaline bisulphites. On treatment with nascent hydrogen it produces a diatomic alcohol, a glycol at once primary and secondary.

Researches on Pilocarpins.—M. Chastaing.—On treating pure pilocarpine with melting potassa there is formed methylamin, but no volatile base having the characters of conicine is generated. The other products are carbonic acid, butyric acid, and traces of acetic acid.

No. 6, February 6, 1882.

This issue is entirely taken up with a notice of the prizes awarded for the past year, and of those proposed for the present season, and the four succeeding years.

Journal für Praktische Chemie.

Nos. 21 and 22, 1881.

Contribution to the Knowledge of the Diazo-phenols.—Dr. C. Böhrer.—The author combats the assumption that the hydrogen of the diazo-compounds cannot be replaced without decomposition. He describes diazo-phenol hydrochlorate and nitrate, para-diazo-phenol hydrobromate and sulphate, para-diazo-dibrom-phenol, its hydrobromate, and the compound of the latter with platinum chloride, para-diazo-dibrom-phenol sulphate, ortho-diazo-dibrom-phenol with its hydrobromate, sodium para-diazo-dibrom-phenol-sulphonate, the corresponding silver and barium salts, para-amido-dibrom-phenol hydrochlorate, amido-dibrom-phenol, and phenol-brom-phenyl-ether.

Dibrom- and Tribrom-Ortho-amido-phenetol and some of its Derivatives.—R. Mœhlan and P. Ehmichen.—The authors enumerate the bromised compound already known, and then describe the bromisation of ortho-amido-phenetol, the behaviour of bromised diazo-phenetols with water, dibrom-diazo-phenetol nitrate, dibrom-phenetol, and tribrom-diazo-phenetol nitrate.

Determinations of Chemical Affinity (Fifth Treatise).—Dr. W. Ostwald.—Not suitable for abstraction.

Decomposition of Glucose and Uric Acid by Alkalies at the Temperature of Incubation.—M. Nencki and N. Sieber.—Glucose is decomposed, whilst sugars of the formula $C_{12}H_{22}O_{11}$ have a greater power of resistance. Cane-sugar remained unaffected. Proteine compounds underwent no profound decomposition on contact with dilute alkalies. On digestion for days with an excess of alkali, there was a slight escape of ammonia, and peptons were formed. Leucin, tyrosin, and glycocholl were not generated. Uric acid was rapidly decomposed by dilute alkalies.

Communications from the Agricultural Physiological Institution of the University of Leipzig.—These consist of a memoir on the quantitative determination of free acids in vegetable and animal fats, by F. Stohmann, and a paper by Dr. v. Rechenberg on the proportion of free fatty acids in organic fats.

Anthology of Modern Chemical Utterances.—H. Kolbe.

Nos. 1 and 2, 1882.

Calorimetric Studies.—Dr. W. Ostwald.—This memoir treats of the reciprocal action of neutral salts. The author remarks that Berthelot, in order to explain the reactions which are contrary to his principles, has latterly begun to regard even the most stable bodies as partially dissociated, whereby the principle totally forfeits its value for the prediction of reactions. The author complains of the recent misuse of the term dissociation in chemical treatises. Instead of confining it to its original significance, decomposition by heat, it is applied in all cases of partial decomposition by whatsoever agents occasioned.

On Phrenosine, a New Nitrogenous Non-Phosphuretted Constituent of the Brain.—J. L. W. Thudichum.—The substance of this paper will be found in the *Annals of Chemical Medicine*, vol. ii.

Remarks on a Treatise by Eugen Parcus "On Certain New Brain Compounds."—J. L. W. Thudichum.—A sharp, but apparently not unjustifiable critique.

Derivatives and Decomposition-Products of Mucic and Dehydro-mucic Acids.—Dr. A. Klinkhardt.—The author finds that pure pyro-mucic acid, prepared from dehydro-mucic acid, and free from iso-pyro-mucic acid, gives with ferric chloride not a green colouration, but a reddish brown precipitate. He has examined the chloride and the amide of dehydro-mucic acid; its behaviour with bromine and with nitric acid; nitro-pyro-mucic acid, its ethyl-ether, and its silver, barium, calcium, and lead salts, and the reduction of nitro pyro-mucic acid by tin and hydrochloric acid, the results obtained being succinic acid, carbonic acid, and ammonium chloride.

Product of the Reduction of Succinyl Chloride and on Normal γ -Oxybutyric Acid.—A. Saytzeff.—The reduction-product obtained is butyro-lacton. The author has examined its conversion into normal γ -oxybutyric acid and into normal butyric acid.

Two New Derivatives of Sulphurea.—M. Nencki and N. Sieber.—The compounds obtained are the sulphurea of methyl-acetylen-carbonic acid and sulphuvinic acid. The properties of both and the salts of the latter are described at some length.

A New Formation of Resocyanine.—W. Schmid.—On acting upon resorcin with acet-acetic ether and zinc with the aid of heat, the authors obtained a compound which proved to be identical with Wittenberg's resocyanine.

Contributions to the Chemistry of the Chrom-Ammonia Compounds.—S. M. Jørgensen.—An account of the bromo- and iodo-purpureo-chrom salts.

Diallyl-ethyl-carbinol.—A. Smirensky.—The author has obtained and examined this compound, which has been hitherto unknown. It is a colourless fluid having the composition $C_9H_{16}O$.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. x., Part 8.

The Greatest Daily Quantities of Rain.—Hermann Ziemer.—At Colberg, Sept. 7, 1880, there fell 102 m.m. in seven hours; at Breslau, August 6, 1858, 114.6 m.m. At Klausthal, in the Harz, the daily maximum observed is 115 m.m., and at Höchenschwand, in the Black Forest, 126 m.m.

Analysis of Rice Soils from Birmah.—R. Romanis.—From the CHEMICAL NEWS.

Influence of the Physical Properties of the Soil on its Percentage of Free Carbonic Acid.—Prof. E. Wollny.—Other conditions being equal the carbonic acid of the soil increases with the temperature and the moisture, so long as the latter does not restrict the quantity of oxygen in the pores of the soil necessary for the decomposition of the organic matter. The proportion of carbonic acid increases with the fineness of the particles of the soil.

Manurial Experiments on Turnips with Soluble and Insoluble Phosphoric Acid.—Dr. Prevost.—A paper read before the Cirencester Chamber of Agriculture.

Experiments on the Relative Value of Soluble and Insoluble Phosphates.

Application of Different Phosphates in the Cultivation of Swedes at Tubney Warren in 1869.—These two papers are translated from the *Journal of the Royal Agricultural Society of England*.

Most Rational Strength of Artificial Manuring for Potatoes and Beets.—Dr. E. Wild.—For potatoes the most rational manuring seemed to be 10 kilos. phosphoric acid + 5 kilos. nitrogen per quarter morgen, whilst for beets, double the above quantities are required.

Manurial Experiments on the Experimental Field of the Agricultural Institute of the University of Göttingen.—Prof. Drechsler.—These experiments relate merely to beets.

Determination of Fat in Milk by means of the Lacto-Butyrometer and the Areometric Method of Soxhlet.—Dr. M. Schmöger, Dr. Eggert, &c.—The use of the lacto-butyrometer is pronounced simpler than that of Soxhlet's apparatus, and the results are considered sufficiently accurate for practice.

Alleged Saccharification of Starch by Water under High Pressure.—Prof. F. Soxhlet.—The proportion of sugar formed is greater the less water acts upon 1 part of starch. It was found that the presence of a trace of free acid, as met with in the potato- and the wheat-starches of commerce, is necessary. If this acid is removed no sugar is generated.

The Acorn and the Helianthus Root in the Manufacture of Alcohol.—Dr. H. Dill.—Both common acorns freed from their shells and the tubers of *Helianthus tuberosus* are capable of being used as a raw material in distilleries.

Physiology and Morphology of the Alcoholic Ferments.—E. C. Hanser.—The author describes *Saccharomyces apiculatus* as distinguished from *S. cerevisia*.

Disturbance of Fermentation by Various Substances.—Prof. M. Märcker.—Amongst the bodies enumerated are acetic, formic, propionic, butyric, and capronic acid, even in traces.

The Bacteria in the Atmosphere.—P. Miquel.—From the *Comptes Rendus*.

Vol. x., Part 9.

Influence of Industrial Gases and Waste Waters upon Soils and Plants.—Prof. G. König.—The author gives the composition of the waste waters of a dye-works, of a wire-drawing establishment, and of pyrites washing. He discusses the influence of sulphurous acid gas, of the waste waters from zinc-works, and of solutions containing common salt.

By What Acid do Plants Effect the Solution of the Phosphates in the Soil.—H. Von Liebig.—The author maintains that this change is effected by oxalic acid, and he suggests potassium oxalate as a solvent for reverted phosphates in manures in preference to ammonium citrate.

Exhaustion of the Soil by Means of Soda Salt-petre.—Dr. A. Emmerling and Dr. G. Loges.—The exhaustion of the soil by a single application of a moderate dose of cubic nitre is very slight in degree. Its continued use requires the simultaneous application of phosphoric acid, and occasionally of potash.

Agricultural Value of Ground Leather.—Prof. A. Petermann.—Without condemning leather, the author recommends farmers who use it to convince themselves as to its special suitability, by check-experiments with manures of known efficacy.

Manurial Experiments on Oats with Steamed and Dissolved Bones.—Dr. A. Emmerling.—The best results were obtained with dissolved bones.

Action of Gypsum upon the Constituents of Wine.—R. Kaiser.—Almost the entire tartaric acid is withdrawn from the wine as an insoluble calcium salt. "Plastered" wines are, undoubtedly, to be considered as sophisticated, since one of their most essential and characteristic ingredients is withdrawn.

Can Magenta Completely Disappear from an Artificially Coloured Wine.—Dr. J. Nessler.—The author considers that, under certain circumstances, magenta may disappear in a few days so completely as not to be capable of detection. Or there may be found an upper stratum free from magenta, whilst this dye is present in the lower part of the cask.

Bulletin de la Société Chimique de Paris.
Tome 36, No. 12.

Remarks on the Preparation and the Use of Molybdic Liquid.—M. Kupferschlaeger.—Among the methods proposed for preparing a stable molybdenum mixture may be mentioned that of Champion and Pellet, who dissolve 10 grms. of molybdic acid in 15 c.c. of ammonia, diluted with 8 c.c. of water, and then pour this clear solution drop by drop, and stirring continually, into 50 c.c. nitric acid diluted with 30 c.c. of water, and let the mixture stand for some days at 40° to 45°; so that it may deposit any silica or phosphoric acid present. The clear liquid is then preserved in a well-stoppered bottle. The author finds that, by still further increasing the quantity of water, adding 30 c.c. to the ammonia and 50 c.c. to the nitric acid, a very sensitive reagent is obtained, which does not deposit any sediment in the course of two months. He considers it unnecessary to add any acid, especially tartaric acid, to the solution of ammonium molybdate if it is free from phosphoric, arsenic, or silicic acid.

Among the methods of using the re-agent, he mentions the following as the simplest. The sample is dissolved in an excess of nitric and hydrochloric acid; there is poured into it a solution of ammonium molybdate (without nitric acid), the mixture is boiled and left to settle. In this manner the process is much simplified, as it is merely necessary to dissolve pure ammonium molybdate in water when required. The nitric or hydrochloric acid must contain no lead, silver, tin, or antimony, and no organic matter must be present, especially tartaric acid.

NOTES AND QUERIES.

Spurious Honey.—Can anyone tell me what is the composition of a material sold on the Continent as honey? It is quite clear, but does not taste like honey, and appears to contain glycerin.—W. H. MANN.

MEETINGS FOR THE WEEK.

- SATURDAY, 25th.**—Physical, 3. "On the Influence of the Form of Conductors on Electric Conduction Resistance," by G. Gore; "On Faure's Accumulator, and on a Simplified Form of Dispersion Photometer," by Profs. Ayrton and Perry. "On the Electric Resistance of Carbon under Pressure," by Prof. S. P. Thompson.
- MONDAY, 27th.**—London Institution, 5.
Medical, 8.30.
- TUESDAY, 28th.**—Institute of Civil Engineers, 8.
Royal Medical and Chirurgical, 8.30.
Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.
Society of Arts, 8. "Scientific and Technical Education in Russia," by Prof. J. F. Hodgetts.
- WEDNESDAY, March 1st.**—Society of Arts, 8. "The Teaching of Forestry," by Colonel G. F. Pearson.
Royal Medical and Chirurgical, 8. (Anniversary).
Pharmaceutical, 8.
Obstetrical, 8.
- THURSDAY, 2nd.**—Royal, 4.30.
Royal Institution, 3. "Geographical Distribution of Animals," by Dr. P. L. Sclater.
Royal Society Club, 6.30.
Chemical, 8. "On the Luminous Incomplete Combustion of Ether and other Bodies at Temperatures below Redness," by W. H. Perkin. "On the Action of Aldehyd on Phenanthraquinon in Presence of Ammonia," by F. R. Japp and F. W. Streetfield. "Application of the Aldehyd and Ammonia Reaction in Determining the Constitution of Quinones," by F. R. Japp and F. W. Streetfield.
London Institution, 7.
- FRIDAY, 3rd.**—Royal Institution, 9. "Roman Antiquities in London," by Mr. A. Tylor.
Geologists' Association, 8.
- SATURDAY, 4th.**—Royal Institution, 3. "The Iliad and Odyssey," by W. Watkiss Lloyd.

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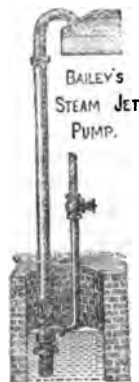
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THE CHEMICAL NEWS

MAR 3 1862
Vol. XLV. No. 1162.

CHEMICAL THEORY OF GUNPOWDER.*

By H. DEBUS, Ph.D., F.R.S.

1. Dr. Jebb† mentions a manuscript as existing at Oxford, entitled "Liber ignium ad comburendos hostes," by Marcus Græcus, probably written in the eighth century, wherein the preparation of gunpowder is accurately described, and Bellani reports that the English used cannon at the Battle of Crecy. Gunpowder, therefore, has been known more than a thousand years, and its use for the purposes of war more than five hundred; nevertheless, no chemical theory of the combustion of gunpowder has hitherto been proposed which will enable us to calculate the quantity of each of the chief products of combustion from the known composition of a given weight of powder, or the amount of heat generated during its metamorphosis. A theory which can solve these problems I have the honour to submit in the present paper to the Royal Society.

2. The constituents of gunpowder—saltpetre, charcoal, and sulphur—are transformed during combustion into the following products:—Potassic carbonate, potassic sulphate, potassic disulphide, potassic sulphocyanate, carbonic acid, carbonic oxide, nitrogen, sulphuretted hydrogen, marsh-gas, ammonia, and hydrogen.

The hydrogen compounds—sulphuretted hydrogen, ammonia, and marsh-gas, the free hydrogen and potassic sulphocyanate—do not, as a rule, amount together to more than about 2 per cent of the weight of the powder from which they have been produced; and as their formation is not the direct result of the reactions which cause the explosion of the powder, they are regarded as secondary products and not considered in a discussion of the chemical metamorphosis of gunpowder.

Besides the potassium salts mentioned, potassic hyposulphite has been found as one of the constituents of the solid residue left by powder after its explosion. According to experiments by the author, which have been confirmed by Noble and Abel, this salt is formed in considerable quantities from potassic sulphide during the analyses of the residues according to Bunsen and Schischkoff's method; and as it is decomposed at 225° C., it cannot be considered as one of the chief products of the combustion of gunpowder.

3. With regard to the products, potassic carbonate, potassic sulphate, potassic disulphide, carbonic acid, carbonic oxide, and nitrogen, the following problems have to be solved:—

(a.) To determine the reactions which cause the formation of these substances, and the order in which they succeed each other, and to represent the *complete* combustion of gunpowder by one chemical equation.

(b.) To calculate from the known composition of a given weight of powder of the volume of gas and the amount of heat generated during its combustion, and to ascertain the relative energies of powders of different composition.

The solution of each of these problems is described in the paper.

4. Noble and Abel‡ describe the quantitative relations of the products of combustion of a given weight of powder of known composition in the following words:—

"(a.) The proportions in which the several constituents of solid powder residue are formed are quite as much

affected by slight accidental variations in the conditions which attend the explosion of one and the same powder in different experiments, as by decided differences in the composition as well as in the size of grain of different powders.

"(b.) The variations in the composition of the products of explosion furnished in close chambers by one and the same powder under different conditions, as regards pressure, and by two powders of similar composition under the same conditions, as regards pressure, are so considerable, that no value whatever can be attached to any attempt to give a general chemical expression to the metamorphosis of gunpowder of normal composition.

"(c.) Any attempt to express, even in a comparatively complicated chemical equation, the nature of the metamorphosis which a gunpowder of average composition may be considered to undergo, when exploded in a confined space, would therefore only be calculated to convey an erroneous impression as to the simplicity or the definite nature of the chemical results and their uniformity under different conditions, while it would, in reality, possess no important bearing upon an elucidation of the theory of explosion of gunpowder."

"(d.) Very small-grain powder, such as F.G. and R.F.G., furnish decidedly smaller proportions of gaseous products than a large-grain powder, R.L.G.; while the latter again furnishes somewhat smaller proportions than a still larger powder, P, though the difference between the gaseous products of these two powders is comparatively inconsiderable."

Noble and Abel exploded successively portions of powder of the same description in their apparatus, and found considerable fluctuations in the relative qualities of the products of explosion in different experiments. These fluctuations they do not explain, but state that "*slight accidental variations in the conditions which attend the explosion*," have as much influence on the relative quantities of the constituents of the solid powder residue as decided differences in the composition of the different powders. And as the exact nature of these "*slight accidental variations in the conditions which attend the explosion*" is not known, they conclude the metamorphosis cannot be represented by a chemical equation.

The author of this abstract has described in the paper the causes of the variations in the relative quantity of the products of explosion, and has explained the experimental results of Messrs. Noble and Abel. And further, he has been able, with this knowledge, to represent the chemical metamorphosis of the English Service powders by an equation.

5. Noble and Abel assume that the samples of fine-grain and pebble powders used in their numerous experiments were, respectively, of the same composition, and that the samples of R.L.G. powder employed in their earlier experiments had the composition given under "I," and those used in the later experiments that given under "II." in the table below.

The composition of the same description of powder is, however, not constant.

I requested the late Mr. Wills to analyse pebble and R.L.G. powders from Waltham Abbey, and the results obtained by him, together with those of Noble and Abel, are given in the following table:—

	R.L.G.			Pebble Powder.	
	Noble & Abel. I.	Wills. II.	Wills.	Noble & Abel.	Wills.
Saltpetre	74'95	74'43	75'10	74'67	74'26
Sulphur	10'27	10'09	8'96	10'07	9'51
Charcoal—					
Carbon	10'86	12'40	12'09	12'12	11'58
Hydrogen	0'42	0'40	0'54	0'42	0'51
Oxygen	1'99	1'27	2'12	1'45	2'55
Ash	0'25	0'21	0'20	0'23	0'33
Water	1'11	1'05	0'85	0'95	0'76

* Abstract of the Bakerian Lecture delivered before the Royal Society, February 23.

† Poggendorff, *Geschichte der Physik*, 87.

‡ *Phil. Trans.*, clxv. (1875), p. 137.

* *Phil. Trans.*, clxv., p. 85.

The samples analysed by Noble and Abel were taken out of the *same barrel*, the one from the upper, the other from the lower parts. These two samples showed a difference of no less than 1.54 per cent of the weight of the powder in the amount of carbon they contain, or the weight of carbon is by one-seventh greater in the second than in the first sample. Mr. Wills found 1.31 per cent of sulphur less than Noble and Abel in the same description of powder. Such differences in the composition of samples of powder of the same nature, together with the usual errors attaching to complicated and difficult analytical operations, are almost sufficient to explain the variations in the proportions of the products of the combustion of gunpowder, as found by Messrs. Noble and Abel, without requiring a theory like the one proposed by M. Berthelot for that purpose.

6. Noble and Abel analysed the products of explosion by means of Bunsen and Schischkoff's method. The author has proved that by the treatment of the solid powder residue, according to this method, a portion of the potassic sulphide is converted into potassic hyposulphite, and under certain conditions into potassic sulphate. The quantities of the two salts so produced vary in different experiments. Hence, the fluctuations observed by Noble and Abel in the relative quantities of potassic sulphide, potassic sulphate, and potassic hyposulphite are partly, if not entirely, due to the method of analysis. Potassic hyposulphite is decomposed at temperatures above 225°; from this fact, as well as from a comparison of the oxygen in the original powder with that of the products of explosion, it follows that the potassic hyposulphite found in powder residues must be regarded as the product of the analytical method.

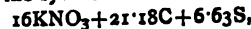
7. It is well known that the sulphides of potassium attack metals with great energy at a white heat. Noble and Abel exploded their powders in a hermetically closed steel cylinder at high pressures, and the products remained after explosion from one to two minutes in a fluid condition at a white heat in contact with the iron of the apparatus. These products contain potassic disulphide. The description given by Noble and Abel of their solid powder residues indicates that they contain ferrous sulphide. The absorption of a portion of the sulphur by the iron will increase the amount of potassic carbonate and diminish the quantity of potassic sulphide and disulphide. The quantity of sulphur so uniting with iron depends on pressure, time of cooling, and other conditions, and will vary in different experiments. We have, then, in the formation of ferrous sulphide, another cause of the fluctuation in the quantities of the products of explosion observed by Messrs. Noble and Abel.

8. It follows from the statements given under Nos. 5, 6, and 7 that there is no reason to assume that the chemical metamorphosis of gunpowder cannot be represented by an equation.

9. Noble and Abel calculate the total weight of the solid residue, which a given weight of powder can produce by its explosion, from the composition of a *portion* of the residue and the composition of the powder. They assume that the portions of powder of the same description used in different experiments were of the same composition. This is, according to the statements under No. 5, not the case. The calculated quantities of gas and solid residue which a given weight of powder can produce will, in consequence, be affected by certain errors. These errors compensate each other if the mean of many experiments is taken.

10. Portions of powder taken from different parts of the same barrel show, according to Noble and Abel's analyses, greater differences in their composition than samples of different descriptions manufactured at Waltham Abbey, pebble, rifle fine-grain, rifle large-grain, and fine-grain powder; hence, we are justified in taking the mean of the analyses of these powders, and expressing thereby the composition of the English Service powder. The mean

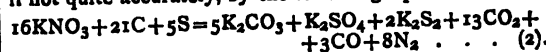
of the analyses of Noble and Abel, and Wills, can be represented by the symbols—



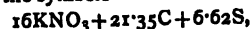
if hydrogen, oxygen, and ash of the charcoal, and the hygroscopic moisture of the powder are neglected.

11. From evidence described in the paper it follows, with a high degree of probability, that during the combustion of gunpowder potassic disulphide, and not monosulphide, as is usually assumed, is formed.

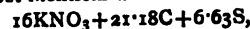
12. If the errors arising from the analytical method are corrected as explained in the paper, if allowance is made for the sulphur which has united with the iron of the apparatus, and, finally, if, for the reasons adduced under No. 9, the mean is taken of the thirty-one analyses published by Noble and Abel, then the explosion of the powders of Waltham Abbey, as conducted by Noble and Abel in a confined space, can be represented very nearly, if not quite accurately, by the following equation:—



1.63 atoms of the sulphur contained in the powder have united partly with hydrogen and formed sulphuretted hydrogen, partly with iron and produced ferrous sulphide. The entire amount of the oxygen contained in the charcoal is eliminated with hydrogen as water, the rest of the hydrogen either remains free or produces methane with carbon and ammonia with nitrogen. The composition of the powder, calculated from the mean composition of the products of explosion of thirty-one experiments, can be represented by the symbols—



which are almost identical with—



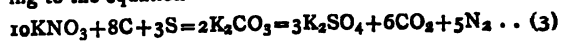
representing the mean composition of the powder found by direct analysis.

13. An increase of pressure during combustion appears to diminish the amount of carbonic oxide, and, in consequence, according to equation 8, to increase the quantities of potassic carbonate, potassic disulphide, and carbonic acid. These fluctuations in the quantities of the products of combustion are, however, *very small*, and may be neglected without serious error.

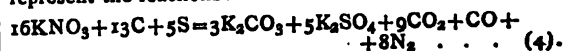
14. Craig had asserted that the nature of the products of explosion of gunpowder depended on the pressure developed during combustion. Karolyi, in order to test this assertion, made experiments with Austrian Service powder, and arrived at the conclusion that pressure had no influence on the quality or quantity of the products furnished by these powders.

The experimental results of Karolyi, and the differences between these results and those obtained by Noble and Abel, have enabled the author to develop a chemical theory of gunpowder competent to explain the observations of Bunsen and Schischkoff, Linck, Karolyi, Noble and Able, and other investigators, and which is in harmony with the thermo-chemical relations of the reacting substances.

According to this theory the combustion of gunpowder takes place in two stages, one succeeding the other. The reactions of the first stage cause the explosion of the powder. *Gunpowders which differ considerably in their composition* are transformed during the first stage according to the equation—



but as it is probable that at the same time some carbonic oxide is produced, the following would more correctly represent the reactions:—



The constituents of the powder, and of the products of combustion are, according to equation 4, nearly in the same ratios as they are according to 3.

During the first stage of the combustion potassic disulphide is not formed.

The oxygen of the potassic carbonate, potassic sulphate, and the carbonic acid, as represented by equation 3, stand to each other in the most simple possible ratios, if these substances are to be produced by the combustion of a mixture of saltpetre, carbon, and sulphur. In other words, equation 3 represents the most simple distribution of the oxygen of the decomposed saltpetre amongst the products of combustion produced during the first stage. And because these products are, according to equation 4, nearly in the same relative proportions as they are according to 3, it follows that the distribution of the oxygen of the saltpetre between potassic sulphate, potassic carbonate, and carbonic acid, as required by equation 4, corresponds nearly to the most simple ratios which can exist under the conditions of the experiments.

The oxygen of the potassic carbonate stands to the oxygen of the potassic sulphate and of the carbonic acid, according to equation 3, as—

$$1 : 2 : 2.$$

If a mixture of saltpetre, carbon, and sulphur shall produce, by its combustion, the greatest possible amount of heat, and if at the same time the products—potassic sulphate, potassic carbonate, and carbonic acid—shall be formed in such proportions that the heat of formation of one shall stand to the heat produced by each of the other two in the most simple ratio possible, then the combustion must take place according to equation 4.

The heat developed by the formation of potassic carbonate stands to that furnished by potassic sulphate and carbonic acid respectively as—

$$1 : 2.05,
1 : 1.04,$$

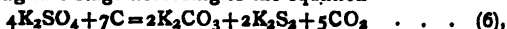
and

if the powder is transformed according to equation 4.

The relations between the quantities of oxygen in the chief products of combustion and those of the heat produced by their formation are, from a theoretical point of view, of the greatest interest.

15. Gunpowder, as a rule, contains more carbon and sulphur than is required by equations 3 and 4.

The carbon left free at the end of the first stage of the combustion now acts on the potassic sulphate formed during this stage according to the equation—



and the free sulphur upon potassic carbonate according to

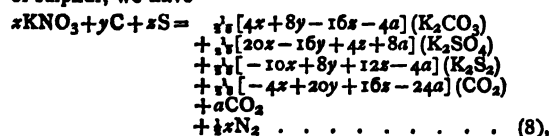


and some of the free carbon reduces carbonic acid to oxide.

These reactions constitute the second stage of the combustion of gunpowder; they are endothermic, heat is not evolved but rendered latent; they are not of an explosive nature, and, in practice, are probably seldom complete. During the second stage of the combustion the temperature of the products of explosion is diminished and the volume of the gas is increased.

16. The quantitative relations between the constituents of gunpowder and the chief products of combustion at the end of the second stage can be expressed by one equation.

If x , y , and z be positive numbers, and a represents how many molecules of carbonic oxide are formed by the complete combustion of a weight of powder containing x molecules of saltpetre, y atoms of carbon, and z atoms of sulphur, we have—



as the general equation of the complete combustion of gunpowder.

By means of this equation the chief products of combustion—potassic carbonate, potassic sulphate, potassic di-

sulphide, and carbonic acid—can be calculated from that portion of a given weight of powder which transforms itself into these products.

The correctness of the equation is proved by the agreement of the calculated numbers with those observed by Bunsen and Schischkoff, Linck, and Karolyi in their experiments on the explosion of gunpowder, and also with the corrected mean numbers derived from Noble and Abel's investigation.

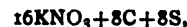
17. The total volume of gas developed by the combustion of a given weight of powder, if calculated according to equation (8), is not affected to more than from one to two per cent if we put $a=0$, and in doing so we gain a considerable simplification of the equation. If V represents the volume of gas evolved by the combustion of a quantity of powder containing 16 molecules of saltpetre, y atoms of carbon, and z atoms of sulphur, and W the units of heat developed by the same weight of powder, we have, on the assumption that $a=0$,—

$$V = \frac{160 + 20y + 16z}{14} \quad (9),$$

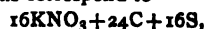
$$W = 1000[1827.154 - 16.925y - 8.788z] \quad (10).$$

The volume of gas becomes greater, and the amount of heat diminishes, when y and z are increased, and *vice versa*.

Quantities of saltpetre, carbon, and sulphur represented by the symbols—



produce the greatest amount of heat and smallest amount of gas, and such as correspond to—



the largest volume of gas and the smallest quantity of heat, if the mixtures are considered which can transform themselves during combustion according to equation (8), in which a is put = 0.

(8.) The product of (9) and (10) divided by 2×1000 ,

$$\begin{aligned} \frac{V \times W}{2000} = & 10440.88 - 12.09y + 1208.39y - 15.95yz + \\ & + 993.867z - 5.022z^2 = E \quad (11), \end{aligned}$$

will assume different values for powders of different composition. The energy of a mixture of saltpetre, carbon, and sulphur will be, *ceteris paribus*, proportional to the volume of gas, and also to the amount of heat produced during its combustion. Hence, the product of the two, E , may be used, according to the proposal of M. Berthelot, as a measure of the relative energies of powders of different composition.

(9.) If in equation (8) x is put = 16, and $a=0$, we obtain—

$$\begin{aligned} 16(KNO_3) + yC + zS = & \frac{1}{16}[64 + 8y - 16z](K_2CO_3) \\ & + \frac{1}{16}[320 - 16y + 4z](K_2SO_4) \\ & + \frac{1}{16}[-160 + 8y + 12z](K_2S_2) \\ & + \frac{1}{16}[-64 + 20y + 16z](CO_2) \\ & + 8N_2 \quad (13), \end{aligned}$$

and from this, if the coefficients of the potassic carbonate, potassic sulphate, and potassic disulphide are put = 0, the equations:—

$$64 + 8y - 16z = 0 \quad (14),$$

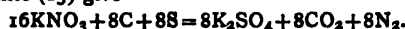
$$320 - 16y + 4z = 0 \quad (15),$$

$$-160 + 8y + 12z = 0 \quad (16),$$

These equations represent in a plane three sides of a triangle. The co-ordinates of points within this triangle represent quantities of carbon and sulphur, which can, with 16 molecules of saltpetre transform themselves according to equation (13), whereas the co-ordinates of points outside this triangle indicate mixtures which cannot do so, such mixtures containing either too much or too little of carbon or sulphur.

The co-ordinates of points on the sides of the triangle represent mixtures which will burn with the production of two, and those of the points of intersection of two sides with formation of only one potassium salt.

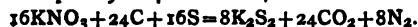
The two sides represented by equations (14) and (16) intersect in point $y=8$, and $z=8$. These values introduced into (13) give—



In the same manner we obtain for the point of intersection corresponding to equations (15) and (16) :—



and finally, the sides whose equations are (14) and (15), intersect in point $y=24$ and $z=16$, hence—

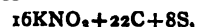


The geometrical construction of the coefficients of equation (13) possesses the great advantage of indicating by the co-ordinates of the points of a triangle the composition of the infinite number of mixtures of saltpetre, carbon, and sulphur which can transform themselves during combustion according to equation (13), and enables us to deduce *geometrically*, as is shown in the paper, the qualitative nature and the quantitative relations of the products of combustion, as well as the volume of gas and the amount of heat developed by each mixture.

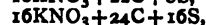
(20.) It is proved in the paper that the composition of a powder which can transform itself during combustion according to equation (13), and for which E in equation (11) shall be a maximum, is indicated by the co-ordinates of the point of intersection of the sides of the triangle represented by the equations (14) and (15).

If, therefore, such quantities of powders of different composition are compared, which contain 16 molecules of saltpetre, the one composed of $16\text{KNO}_3 + 24\text{C} + 16\text{S}$ will possess the greatest energy.

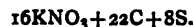
(21.) If E is calculated for *equal weights* of two powders of different composition, the difference of the values of E is found to be *very small*, if the powders contain from 21 to 24 atoms of carbon, and from 8 to 16 atoms of sulphur for every 16 molecules of saltpetre. Equal weights of the two mixtures—



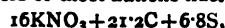
and



give for E [equation (11)] the values 16.84 and 16.95 respectively. If, therefore, a mixture of saltpetre, carbon, and sulphur is required, which shall possess the greatest or nearly the greatest amount of energy, and at the same time contain the smallest amount of carbon and sulphur compatible with this condition, theory would point to the mixture—



The gunpowders of most nations fluctuate about—



which numbers are very near those required by theory.

ON CÆSIUM.

ONE of the first fruits of spectrum analysis was the discovery of the two alkaline metals cæsium and rubidium, by Bunsen and Kirchhoff. The salts of these metals were closely examined, and found to show a similarity with the compounds of potassium more complete than had yet been observed among analogous bodies. The two metals are the most electro-positive of all known substances, and form consequently the ultimate members of the electro-chemical series, being more positive even than potassium. With this property is naturally combined an exceptional affinity for oxygen, which, especially in the case of cæsium, is so great that the isolation of the metal was found impossible, and the discoverers, being unable to separate it from the accompanying non-metals, had to content themselves with the examination of its compounds. Rubidium, however, was isolated by Bunsen, and was described as a light metal deceptively similar to potassium, but much more fusible.

Carl Setterberg has lately effected the isolation of cæsium. His method was the electrolysis of a fused mixture of cæsium and barium cyanides. Having relatively enormous quantities of the precious materials at command,—by means of a process of his own invention he has prepared 40 kilos. rubidium and 10 kilos. cæsium-alum,—he has produced cæsium as a metal very similar to the remaining alkali-metals, silver-white, very soft and ductile. Its melting-point is 26.5° , and its sp. gr. 1.88. On exposure to the air it ignites spontaneously, and if thrown upon water it burns like potassium, sodium, and rubidium. Setterberg has proved anew that in consequence of the affinity of the metal for oxygen, and the volatility of its salts, the preparation of cæsium by igniting its carbonate along with carbon—according to the ordinary method for obtaining rubidium and potassium—is quite impossible.—*Annalen der Chemie und Pharmacie*.

NOTE ON THE VOLUMETRIC DETERMINATION OF NITROGEN.

By A. BERNTHSEN.

IF in volumetric determinations of nitrogen the requisite carbonic acid is evolved,—not in the combustion-tube, but by means of a special apparatus,—there is always obtained an excess of nitrogen due to the air present in the marble. This evil may be avoided by putting the marble first into a bottle with thick sides, covering it with water, and then evacuating it well under the water air-pump. In this manner the air is as good as totally expelled, especially if the bottle is shaken from time to time, so that the bubbles formed on the surface of the marble may be detached. The results obtained in this manner leave little to be desired on the score of accuracy.—*Zeitschrift für Analyt. Chemie*.

NEW METHOD FOR DETERMINING THE GYPSUM CONTAINED IN WINES.

By M. E. HOUDARD.

I SUBMIT to the Chemical Society of Paris a method which has rendered me substantial services for more than a year, for determining, in a quick and easy manner and with a sufficient approximation, the proportion of potassium sulphate, or rather the corresponding quantity of sulphuric acid, found in almost all Mediterranean wines from the "plastering" carried on by the growers.

This method does not offer much interest from a scientific point of view, but it may prove important for all those who are concerned with the analysis of wines of ordinary consumption. It is based upon the formulæ of M. Poggiale, modified in 1876 by M. Marty, Professor at Val de Grace; but in place of indicating merely if a wine contains more or less than 2 grms. potassium sulphate per litre, it enables us to determine the proportion to about $\frac{1}{2}$ a gram. per litre: its chief merit is that, unlike the methods at present employed in laboratories, it is within the reach of all.

The process requires ten test-tubes placed in two parallel rows, five in each row; a pipette of 25 c.c., graduated in five divisions, each of 5 c.c.; a burette graduated in five divisions, from 0.5 to 2.5 c.c., each division consequently containing 0.5 c.c.

It being known that 10 c.c. of M. Marty's standard liquid precipitates 0.1 grm. potassium sulphate per litre, we begin by pouring into each of the test-tubes of the first row 5 c.c. of the wine in question. We then add to each of these tubes, by means of the burette, Marty's standard liquid, pouring into the first tube 0.5 c.c., into the second 1.0, and so on till the fifth tube receives 2.5 c.c. The

contents of the five tubes are heated and filtered respectively into the five tubes of the second rank. It is then merely needful to add a drop of the standard liquid to each of the second set of tubes, and to note in which tube it produces a faint turbidity. If, *e. g.*, this turbidity appears in No. 2 and not in No. 3, it appears that the wine contains more than 2 grms. per litre of potassium sulphate and less than 3 grms. Hence it may be concluded that the proportion is about 2.5 grms. per litre.—*Bulletin de la Soc. Chimique de Paris.*

ON THE DETERMINATION OF SULPHUR IN PYRITES.

By F. BECKMANN.

THE methods of Lunge and Fresenius have afforded a satisfactorily accurate and expeditious means of determining the sulphur in pyrites. As a third process, which also gives good results, I recommend the following modification of the potassium chlorate method:—Half a gm. of finely ground pyrites (sifting is not absolutely necessary) are mixed in a large platinum capsule with the well-known mixture of 6 parts sodium carbonate and 1 part potassium chlorate. The mixing is effected with a platinum spatula, and is then made more complete by gentle rubbing with an agate pestle fixed to a wooden handle. The whole is then fused over the blast-lamp. The aqueous solution of the melt is first poured into a beaker to avoid spitting, and thence into another tall beaker containing an excess of hydrochloric acid. The filtered solution is heated and precipitated with hot barium chloride, heated gently upon the sand-bath for a time until the liquid standing above the precipitate has become clear, and is filtered at once. The burnt ores in sulphuric acid works have been for a long time assayed for sulphur by this process. I take about 2 grms. of burnt ore to from 20 to 25 grms. of chlorate mixture.—*Zeitschrift für Analyt. Chemie.*

THE SCHOOL OF MINES, BALLARAT.

WE have received the annual report of this establishment presented to the Meeting of Governors, February 9th, 1881, and perceive with pleasure that good progress is being made. The subjects taught, as a matter of course, include mathematics, mining-, and land- and engineering-surveying, mechanics and natural philosophy, mechanical engineering, geology, metallurgy, chemistry, mining (both scientific and practical), magnetism, and electricity. We are rather surprised to find *materia medica* and physiology, botany, and pharmaceutical chemistry among the subjects taught. A proposal made and carried at the Annual Meeting, to open a class for oil-painting, further strikes us as unusual. Some of the professors seem to be, if not overworked, burdened with too great a variety of subjects. Thus Mr. Jos. Flude has to teach metallurgy, assaying, chemistry, botany, and pharmaceutical chemistry. F. M. Krausé, in addition to his important duties as Curator of the Museum, occupies the chairs of mineralogy, geology, electricity, and magnetism. We must express a hope that the Institution will receive such a measure of support as may enable it to introduce a more complete division of labour among its officials.

The museum is evidently improving. Lack of room—a torment from which few curators are exempt—is not absent, and, as the heaps of undetermined and wrongly determined minerals are being labelled and duly classified, the available space is felt to be insufficient. The Curator has arranged the entire collection upon stratigraphical considerations, geographical being subordinated. The heads of the School evidently entertain the bold but most

laudable plan of forming a collection illustrating the geology and mineralogy not merely of the whole of Australia proper, but also of New Zealand and the Fijis. There are at present 1132 specimens of minerals, and 760 of rocks and fossils.

Turning to the report of the Superintendent of the Laboratories, we find that these are fitted with eighteen work-tables, each duly supplied with gas, water, and apparatus, and affording room for thirty-two students. The Superintendent suggests that a tolerably good spectroscope should be obtained, and that a special balance room should be provided. The metallurgical laboratory is arranged for twelve students, and is fitted with twelve reduction furnaces, three cupelling furnaces, and a small blast-furnace.

The botanical department is also active. It has formed a collection of about a thousand plants (specimens, or species?), and the Botanical Garden is said to be well kept. Perhaps the phytological studies are arranged with a too preponderating reference to pharmacy.

The Ballarat School of Mines will undoubtedly contribute greatly to the development of the resources of the Australian Colonies.

THE OCCURRENCE OF OPALS IN CENTRAL AUSTRALIA AND QUEENSLAND.*

By JAMES R. M. ROBERTSON, M.D., F.G.S., F.R.G.S.

AT the request of your Secretary, and some of the older members of this society, I have prepared a few remarks upon "The Occurrence of Opal in the Colony of Queensland," and the geological and physical aspects of the country in which they are found.

Very few of those to whom I speak on Queensland are aware that its surface area is about 8½ times that of Great Britain; that 30 years ago there were not more than 1800 white people settled in this vast extent of country; or that at present it can only boast of a population of 217,000, or rather less than one person to every three square miles.

The northern territory of Queensland is mountainous; it is covered by dense tropical vegetation, and is peopled by hostile tribes of aborigines. Of this region, very little indeed of a positive character is known.

The east coast of the Colony is fringed over its whole length by a high mountain chain, for the most part composed of granite. In parts these mountains are highly metalliferous, copper being extensively distributed around Mount Perry and Rawbelle, and at Copperfield; and gold—both alluvial and in quartz reefs—is found over the whole extent of these ranges. The principal gold mining localities are—Gympie in the south, around Mount Perry, Rockampton and Morinish, Charters Towers, and Nebo, inland from Bowen. The Palmer and Hodgkinson districts in the north, while in the mountain ranges that join the east coast with the Gulf of Carpentaria, the Etheridge, Woolgar, and Gilberton gold fields have been opened up. In the far west the Cloncurry copper and gold fields (that I had occasion to visit) exist among the outliers of the M'Kinlay ranges, and from this field the richest ores of copper and the finest gold in all Australia is obtained.

Queensland minerals are all of a high order in respect to quality and productiveness; but, up to the present moment, they have not received that attention from capitalists that they deserve. Its quartz reefs carry a higher average of gold than any in Australia; yet, from the rudeness of the manipulative processes, and the perfunctory methods of mining practices, their working has not been attended with the success that better systems

* Paper read before the Glasgow Geological Society and Chemical Section of the Philosophical Society, January 23rd, 1882.

would have insured. I am pleased to be able to make an exception to this general statement in favour of Charters Towers and Gympie, where several complete recovery plants have of late been erected.

The coast ranges rise to an average altitude of 2000 feet. From this elevation, plateauxs, or tablelands, extend inland. The granite formation has been pierced by great belts of volcanic or intrusive rocks; and very large areas of these tablelands are covered by slabs of vesicular basalt in process of decay—the decomposition given rise to deep black soils. It is a curious circumstance, that these basaltic blocks are confined to the top, or seem to float upon the surface; the soil underlying them being entirely destitute of stones. Other portions of the plains are composed of chocolate-coloured or red soils, resulting from the decay of intrusive rocks containing iron. Further inland, these black and red soils gives place to extensive Downs, composed of deep, darkish grey soil, overlying rocks, evidently of oolitic or cretaceous age, and exhibiting in parts a peculiar cone-in-cone structure. All these plains are covered by a great variety of the most nourishing and permanent grasses. These plains, over several degrees of latitude and longitude, are perfectly level, and, for the most part, are featureless and destitute of trees, and innocent of roads or tracks. Over them, the traveller rides—often guided by the compass—with no landmarks or milestones to relieve the tedium. He looks constantly over an apparently illimitable sea of luxuriant grass. In the morning he sees the sun rise out of the grassy sea; he watches it ascend into the blue vault of a cloudless sky, again to set, with gorgeous splendour, to illuminate a similar expanse of verdure.

From the Gulf of Carpentaria, a midrib of hill-ranges run south through the continent. 250 miles south of the Gulf the M'Kinlay ranges branch off to the east, and from these ranges run south to form the Grey, Coleman, M'Gregor, and Cheviots, that determine the several watersheds of the interior.

The southern division of Australia, bounding upon Victoria, New South Wales, and South Australia, is more park-like in character than the central division just referred to. A large portion of it is covered by stunted trees or a scrub of peculiar description; its stunted character being due, no doubt, to the uncertainty of the seasons and the protracted droughts to which this part of the colony is subject.

The country is covered by recent rocks, chiefly of soft, friable, unbedded sandstones and indurated clay. It is intersected by low ridges or belts of porphyritic or quartzose rocks. On one of these hard vitreous ridges I noticed a rather curious circumstance. On the very apex of the flinty ridge, with a perfectly arid landscape all around, the savage natives had dug, at a great expenditure of labour, very possibly with rudestone implements, three small holes, or native wells. In these wells water is at all times found, and they have never been known to overflow. They have possibly been sunk upon some small crack or fissure that exudes water.

The River systems of this part of the colony are peculiar. In the dry season they appear to be composed of connected lines of water holes, known as "Billabongs." During times of drought these are so many reservoirs for the storage of water; but during the rains, they overflow, and are often 20 miles broad. Such are the Maranoa, Warrego, Paroo, Bulloo, Blackwater, and Cooper's Creek River systems.

The stunted scrub that covers large areas of country is called Mulga. Its leaves are small, fleshy, unctuous, and lanceolate, and of a dark olive-green colour. Where the soil is particularly deep and rich, open plains occur, that while moisture remains are covered with abundant and luxurious grasses. This is the principal cattle rearing district of Southern Queensland, where great mobs of bullocks roam at will "on a thousand hilla and bosky dells," living solely on the grasses and nutritious shrubs that abound, until they are collected, and travelled for hundreds of miles, to the Adelaide or Melbourne markets.

The district is subject to droughts. It was near to this that the explorers Burke and Wills, with their party, perished many years ago. When I rode through it in July of last year, not a drop of rain had fallen for over 22 months; and then there was no sign of a change. The grass during such prolonged droughts gets scarce and burnt up, while incalculable quantities are annually consumed by bush fires. At these times cattle enter the Mulga scrub and live, and fatten upon the leaves, travelling once a day, to the nearest waterhole, to slake their thirst; or they feed upon the cotton, or salt bush, that, instead of grass, covers some of the plains.

Very few Marsupials are found in this region; their numbers are probably kept down by the swarms of "dingoes," or native dogs that abound. To cattle these dogs do little damage: but among sheep they cause such destruction that squatters systematically poison them with strychnine. After nightfall the discordant howls of these pests around the camp fires is quite loud enough to awaken anything human, save the easy-minded bushman, who, exhausted by a long ride, has rolled himself in his blanket, and with his head on his saddle has shut his eyes on the twinkling constellations, and with half open mouth is snoring in a manner that speaks volumes for the simple diet of bush life and the invigorating freshness of the air.

The climate is salubrious and healthy. During the summer months of November, December, January, it is hot, but dry, the thermometer averaging 105° to 110° in the shade. The rainy season occurs as a rule in February, when a large part of the country is under water. During March, April, May, the air is cool, the skies clear, the mornings cold, and the surface of the earth covered with flowers and verdure. In June, July, and August, the days are bright and cool, the nights being cold or frosty. September and October are the spring months, when the temperature increases, and showers freshen the parched earth. In the pure atmosphere of these regions there are no febrile ailments, and little disease of any description, save the lesions, and the drivelling idiotcy caused by drinking doctored rum or 1 star brandy, at 17/6 per bottle. However excellent the breed of cattle or sheep may be in the colony, there can, I think, be little doubt that its present tendency is to breed a most depraved and demoralised variety of the genus homo.

We had for days been riding through a broad belt of rough and disconsolate scrub, breathing an atmosphere of pulverulent dust; but after crossing the Grey range we enter a broad expanse of green and grassy downs. Breathing the ethereal and invigorating brilliance of the dry air, our spirits rise, and we strive to forget the rough usage, the forbidding desolation, and the dust of the past week, borne, as we suppose, with exemplary fortitude and Christian forbearance. The silence is profound. As we ride onwards, the feeling increases that, as far as the absence of life or habitation, or occupation is concerned, we might be

"——— the first that ever burst
Into that silent sea."

Behind us the higher eminences of the Grey range rise as out of a cloud of gleaming vapour, and these, from their appearance, are known as the *Hay Ricks*. Around us, detached squadrons of Emus, run in uncertain lines; and before us, over a sea of verdure, is the mirage of a great lake. We cross stony ridges, or belts of vitreous and highly transmuted siliceous rocks, over which our unshod horses walk wearily, and once again we cross the grassy plain, bearing almost due west. Water is scarce, sometimes spaces of 25 miles separate the water holes; in some of these a liquid is seen resembling in colour and consistency thin white paint, and this decoction is imposed upon strangers as water. It tastes strongly of "cow."

We cross salt bush plains, and belts of flaggy sandstones, and at last—above the horizon—the peculiar outline of the ranges, near the locality where he

explorers Burke and Wills perished, rise into view, and lends variety to the scene.

Next morning, we collect our shivering horses by moonlight (the grass and ground being covered with hoar frost, and the pools with ice); and ere the orb of day had arisen, we were threading a devious way over frightfully stony ridges; and through thick, prickly scrub, that tear the emblems of our civilisation, and scratches our faces, to emerge from it in a condition of doubtful respectability. We ascend a range composed of gritty sandstone, with slopes, covered with fallen blocks and decaying fragments, piled up in chaotic confusion. Some of the hill masses are of blood-red colour, and exude salts of magnesia. Some are olive coloured, or ochrey yellow. Some resemble Bathstone, and some are a blending of all these. The lithological character of these rocks are by no means distinctive, but they are evidently of tertiary age. Porphyritic dykes traverse, but do not appear to disturb these rocks. High overhead are crumbling cliffs of mottled sandstone of curious outline. Around us the heat quivers in the hair, and against their mural sides, the bright sun dances with a fierce delight. By dangerous paths, we continue to ride up the slopes of these fantastic-shaped hills, and, by some unaccountable accident, arrive in safety at the top.

Not a sound (save the panting of our horses) disturbs the solemn and all-prevailing silence. We are alone with nature in the centre of a great continent, and we feel that he, indeed, must possess a dull and incurious mind, who is not impressed by the singularity and the charming loveliness of the scene. Twenty miles off, across a grassy and park-like plain, the Coleman and M'Gregor ranges rise, clear and distinct, amid the flood of light. The outline is wonderfully lovely. In the foreground a number of cone-like and castellated hills, of all colours, rise from the plain; the more connected ranges of the background appearing as if capped by numerous and enormous fortifications. Some of the isolated conical hills terminate in sharp apexes or spikes; others terminate with flat circular crests and perpendicular red sides, rising out of slopes of yellow or reddish earth partially covered by struggling vegetation. The whole of the hills have approximately the same level or elevation. Their contour being entirely due to the effects of climate, operating over incalculable periods of time. I have endeavoured to represent the outline of these hills in sketch No. 1; but I regret that I cannot convey to you any idea of their aspect, as I saw them, through the clear ambient air—rising out of a carpet green, with the sun to illuminate them, and distance to soften, and to heighten the effect.

Similar country, geologically, extends through about 3 parallels of latitude, and about 2 of longitude; and within this area, siliceous minerals, such as quartz in various forms, agates, calcedony, carnelian and opals are found. With the latter only I propose to deal.

These rocks are evidently of Tertiary age; but they possess no very distinct or typical characters. The component parts are gritty sand, or earth. The bedding is obscure, or false; and the colour is apparently due to the admixture of protoxide of iron in varying quantities. The colour is, however, striking; blood red, grey, brick red, cream coloured, olive, yellow, or mottled. These colours may, within a few yards, insensibly blend into one another, or they may be separated by a distinct and sharp line of demarcation, as in the specimen that I now show you.

In certain parts these loosely aggregated sandstones are held together, (as are the great sandstones that overlie the coal formation of N.S.W.), by irregular mahogany coloured feruginous bands. These segregations of iron have, in some parts of the district, formed fissures within themselves, and into these crevices a fine siliceous fluid has been introduced, and become consolidated. In other localities, where the necessary conditions have been present, these siliceous threads have become opalised; and

where these have absorbed infinitely minute traces of nickel, or manganese, or iron, or all three, they exhibit all the lovely play of colours distinctive of the precious or the fire opal. The specimens will serve to illustrate this condition.

Again, while some of the more aluminous beds have been subjected (we shall suppose) to the influence of heat, the plastic matrix has been rendered vesicular, and a number of the cavities so formed have (by subsequent infiltration) been filled by silica, which has become opalised. Specimens labelled No. 17 simplifies this condition.

Again, as we approached the margins of this district, we passed over certain beds of indurated and transmuted schists, and in these, small nodular concretions of siliceous ironstone can be picked out. These little flattened spheres are about one inch in diameter. On breaking them, numerous minute crevices are seen to radiate from a centre, and these hair-like fissures have been filled by a plastic mass, which has become opalised, but of no value whatever. In the reniform nodules of C. B. ironstone that are found in the clays, or in the soft shale beds of our coal measures identically the same appearances are to be seen; only, in the latter case, the septaria are filled with ordinary quartz.

Approaching the main ranges, almost every other ridge is covered with splinters of a milky, or opaque variety of opal. Specimens Nos. 1 and 5 illustrate this, and the last named variety of opal.

Without going more into detail, I must ask you to believe that it is only within a certain very small area, of this extensive opal-bearing country that opals of any commercial value have been found. I feel that I need scarcely mention that opal is a siliceous mineral—an analysis of precious opal showing 90 per cent of silica and 10 per cent of water. That it is considered an unlucky stone by ignorant and superstitious people; that its beautiful combinations of colours probably depends upon the presence of exceedingly minute proportions of some colouring-matter, such as those produced by iron, nickel, or cobalt—the colour being intensified by the presence of numerous invisible fractures.

I may inform you that over very large tracts of country, in the lower Bulloo, and Barco districts, opal is found filling the narrow and irregular fissures of a feruginous matrix, or in delicate scales, so thin, that they appear as if painted on to the matrix; but these, however beautiful, cannot be utilised by the lapidary.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, February 25th, 1882.

Professor G. C. FOSTER in the Chair.

New Members:—Prof. G. F. Fitzgerald, Trinity College, Dublin; Mr. C. Richardson; Lieut. H. I. Dockrell, R.N.; Mr. W. Ford Stanley; General H. Hyde, R.E.; Mr. J. Buchanan.

Prof. W. E. AYRTON, F.R.S., read a paper on "*Faure's Accumulator*," giving the results of experiments made by him and Prof. Perry on the efficiency, storing power, and durability of the battery. The efficiency was got by measuring the power put in and comparing it with that taken out, by means of Perry and Ayrton's voltameter and ammeter. The authors found that the cell has great resuscitating power if left insulated after all the current appears to have been discharged. Care had to be taken to see that the cell was quite discharged by letting it stand on open circuit for intervals and discharging between whiles. When this was done they found that the total

loss for charges up to one million foot-pounds need not be greater than 18 per cent. With slower charges they got a loss of only 10 per cent. As to the storage, a mean current of 18 Ampères gave after eighteen hours' discharge (six hours on three consecutive days) 1,440,000 foot-pounds of work, equivalent to 1 horse-power in forty-three minutes. The cell contained 81 lbs. of red-lead, thus making a capacity of about 18,000 foot-pounds per pound of red-lead. The cell showed no deterioration after two months of work.

Prof. AYRTON then described a new form of his Dispersion Photometer, which greatly reduces it in size and convenience. The principle of this instrument has already been described to the Society by the authors. It consists in using a concave lens to disperse the stronger light, and thus obviate the necessity of putting it at a great distance if it is very powerful, such as an electric light. The powers of the two lights are compared by the eye in estimating the intensity of the shadows of a rod thrown on a white screen of blotting-paper by the two lights simultaneously. A sperm candle is used as the standard, and it is placed on a movable stand at an angle to the path of the other beam through the lens. Both the lens and candle can be shifted to and from the screen along a scale giving their distances, and the stronger beam is reflected from a small mirror. This mirror is ingeniously fixed so as to reflect the ray from the same part of its surface whatever angle it is placed at, and thus the power of an electric light can be accurately given for every angle along which the ray travels from the lamp. Observations are taken through red and green glasses to get a better measure of the power of the light. Prof. Ayrton has found that ordinary air absorbs the green rays of the electric light very strongly, and hence, in order to get a proper test of an electric lamp, the photometer should not be far from the light. The new dispersion photometer shown is the only one admitting of this precaution.

Mr. SHOOLBRED stated that he had found from experiment that the carbons of the Swan and Maxim incandescent lamps bore a much higher current without breaking when fed from a Faure accumulator than from a dynamo-electric machine.

Prof. AYRTON corroborated this statement, and said that he had obtained a light of 800 candles from a Maxim lamp fed by an accumulator.

Prof. SILVANUS THOMPSON then read a paper "On the Electric Resistance of Carbon under Pressure." It was generally stated that the resistance of carbon diminished under pressure, but he had found from recent experiments that the diminution observed was really due to the contact between the electrodes and the carbon. Under pressure there are more points of contact between the metal and carbon than without pressure. The result has an important bearing on the action of the carbon relay, rheostat, and microphone transmitter.

Prof. AYRTON pointed out that as carbon apparently diminished in resistance under a rise of temperature, this would seem to indicate it as a compound substance, since only simple substances seemed to increase in resistance with rise of temperature.

Prof. GUTHRIE recalled that Dr. Moser had suggested that the alteration of the resistance of selenium under light was an effect of contact.

A paper was read by Mr. G. GORE, "On the Influence of the Form of Conductors on Electric Conductive Resistance." His experiments were designed to show whether there was a difference of resistance in certain liquid conductors under the positive and negative current. None was discovered.

Dr. HOPKINSON, F.R.S., read a paper "On the Refractive Index and Specific Inductive Capacity of Transparent Insulating Media." He inferred from tried experiments and the electro-magnetic theory that glass had a high refractive index for rays of very long wave length.

Dr. J. H. GLADSTONE suggested that the point should be tested by experiment, and that the method of photographing the red rays might be employed.

Mr. J. MACFARLANE GRAY explained that an objection to one result of his former communication to the Society on the specific heat of steam was really a confirmation of it, as Regnault's value was erroneous.

CORRESPONDENCE.

SULPHUR IN SHALE NAPHTHA.

To the Editor of the Chemical News.

SIR,—In your abstract of the *Berliner Berichte*, vol. 13, No. 12, there is a note by Kalstadt on the occurrence of sulphur during the dry distillation of coal-tar. I may in this connection be permitted to state that sulphur occurs also during the fractional distillation of shale naphtha.

Shale naphtha is absorbed by means of scrubbers from the gases liberated during the destructive distillation of shale for paraffin oils. The crude product contains a very large quantity of sulphur compounds, chiefly sulphides and sulphuretted hydrogen. This crude product, in the process of refining, is treated with the strongest sulphuric acid, and then with excess of caustic soda, sp. gr. 1.360, after which it is distilled. While the light or more gaseous portions are being distilled over, the sulphur is liberated in greatest quantity, and makes its appearance as minute crystals round the water-lute of the separator. This mode of distillation cannot, however, be said to be dry distillation, inasmuch as the still is urged by steam alone. It is very remarkable that sulphur should separate in this form after the naphtha has been treated as indicated above. The more gaseous portion of the distillate smells strongly of garlic, but affords no indication of sulphur by the ordinary methods of testing for such.

Some time ago I mentioned the occurrence of this sulphur to an eminent chemist, who suggested that it was probably due to a hydrocarbon disulphide, which undergoes decomposition in the process of distillation. This view is perhaps supported by the observation of R. Otto, *Berliner Berichte*, vol. 13, No. 12, that aromatic mercaptans are converted into disulphides by the action of sulphuric acid; and this suggests the question—May not the sulphur compounds present in the crude naphtha be similarly affected by sulphuric acid?

Sulphur is also found in considerable quantities in the drips from the gas mains or condensers from shale retorts; but the production of sulphur in this case is well known and easily understood, viz., the action of sulphites upon sulphides. I think the existence of sulphur in the distillation of coal-tar can be similarly explained. Thus, during the destructive distillation of the coal, sulphuretted hydrogen is liberated in greatest abundance, while the maximum yield of gas is being produced. After the make of gas begins to fall off, the continued action of the exhauster draws in small quantities of air through the retorts, which burn the sulphur of the pyrites left in the coke, thus forming sulphurous acid, which, on condensation, reacts on the sulphuretted hydrogen with the production of sulphur. This sulphur is dissolved or absorbed by the naphtha, and afterwards eliminated on distilling the tar.—I am, &c.,

ROBERT TERVET, Manager.

Clippens Oil Works, by Johnstone,
February 24, 1882.

A Sulphur Oxychloride.—J. Ogier.—This new compound has been obtained by heating together to 250° in a sealed tube, a mixture of equal weights of sulphur chloride and sulphuryl chloride. It boils at 60° to 61°, and is readily decomposed by heat. It is a deep red liquid of the sp. gr. 1.656. Its vapour-density taken with Meyer's apparatus is given as 3.98, 3.84, 3.75. The author ascribes to it the formula S_2OCl_2 .—*Comptes Rendus*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 7, February 13, 1882.

Double Salts formed by the Haloid Salts of Mercury.—M. Berthelot.—A thermo-chemical study. The author remarks that the complete theory of saline reactions requires a knowledge of the formation of all the compounds capable of existing, i.e., of the simple salts, hydrated and anhydrous, and also of the double salts, the acid and the basic salts, which may be formed either in the moist or the dry way. Their part is especially important in the study of the metallic salts, by reason of their formation-heat and their state of dissociation. If this double property is known, the inverse displacements and the equilibria are a necessary consequence. He has already developed this theory for the acid salts, and he now proposes to enter upon a further application by the examination of the double salts of silver and mercury. For this purpose it was necessary to measure in the first place the formation-heat of an entire group of bodies, comprising the principal double salts, which may take their rise in a given decomposition. The author has done this for the salts of mercury with reference to the derivatives of the four fundamental hydracids, the hydrochloric, hydrobromic, hydriodic, and hydrocyanic.

Researches on the Nitrogenous Acids derived from Acetons.—G. Chancel.—The author's general conclusions are that the acetone of a normal acid gives a nitrogenous derivative, which reducing agents transform into the next lower homologue of the acid generating the acetone. On the contrary, the acetons of isomers of the normal acid pass over several stages. The formation of these nitrogenous acids is a characteristic reaction of the acetons, and renders it possible to distinguish the primary alcohols from the secondary and the tertiary. In certain cases it is capable of giving precise indications on the internal constitution of the acids and the alcohols.

Electric Actions in like Conductive Systems.—M. Deprez.—A mathematical paper, not capable of useful abstraction.

Electric Transfer of Energy to Great Distances.—M. Deprez.—With Gramme machines of the small kind, weighing about 100 kilos., and modified according to the principles which the author has indicated, he has obtained a work of 37 kilogrammetres, the resistance interposed between the motor and the receiver being 786 ohms, representing the distance of 78.6 kilometres of ordinary telegraph wire. This transfer is effected without the appearance of sparks at the brushes, the machine remaining perfectly cold, and without the necessity of taking special precautions for the isolation of the conductors.

Methods of Comparing Coefficients of Induction.—M. Brillouin.—The author concludes that it is easy to construct two coils, such that their mutual induction-coefficient may be calculated with any desired precision. By means of the methods of comparison of which the author has undertaken the study, the special or mutual coefficients of induction of any coils may be determined to within less than 1-2000th.

Generality of the Electro-chemical Method for the Figuration of Electro-chemical Lines.—A. Guéhard.—The author proposes the following law:—If we place at a very small distance from a slender horizontal section of metal exactly fitted to the sides of an electrolytic trough, any assemblage whatever of vertical cylindric electrodes, the coloured rings which take rise represent with a very close approximation the theoretic system of equipotential lines which would be given by the direct application of

these same electrodes upon a conductive plane taken within the same limits.

Hydrodynamic Experiments: Imitating Electromagnetic Phenomena by Liquid Currents.—C. Decharme.—Not capable of useful abstraction.

Magnesium Oxochlorides.—G. André.—A thermochemical study. The author has obtained and examined the following compounds:—

$MgCl, MgO + 16HO$; $MgCl, MgO + 6HO$;
 $MgCl, 10MgO, 13HO$; $MgCl, 10MgO, 16HO$,
and another compound containing the same relative proportions of magnesium chloride and oxide with 18HO.

Action of Potassium Cyanide upon Potassium Trichloracetate.—E. Bourgois.—The author has obtained a crystalline compound, which he has not yet examined.

Formation-Heat of Hydro-ferricyanic Acid.—M. Joannis.—The author adopts the number +280.5 cal.

Galactine.—A. Muntz.—The author has isolated this compound from the seed of lucern. It closely resembles the gums, having the composition $C_{12}H_{10}O_{10}$. It is dextrorotatory. It yields much mucic acid on treatment with nitric acid, and yields saccharine matters if boiled with dilute mineral acids. In its physical properties it is identical with the galactose derived from milk sugar. The author suggests that it may be the material whence female herbivorous animals derive the elements for the sugar of the milk secreted.

The Aconitates.—E. Guinochet.—The author gives the preparation, properties, and formulæ of a number of the salts of aconitic acid.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. December, 1881.

"Denaturation" of Alcohol by the Addition of Wood-Spirit.—Prof. A. W. Hofmann, Drs. Kraemer and Loewenherz.—The authors admit that, in view of the various industrial purposes to which alcohol is applied, no one ingredient can be used in all cases to render it unfit for human consumption. They propose that spirit used in the manufacture of aniline colours should be mixed with 5 per cent of wood-spirit, instead of 10 per cent as heretofore. Alcohol used in making lake-colours for paper-hangings may be mixed with $\frac{1}{4}$ per cent oil of turpentine, and that for mercury fulminate either with the same proportion of oil of turpentine or with 0.025 per cent of animal oil.

January, 1882.

This number contains no chemical matter.

Bulletin de la Société Chimique de Paris,
Tome 36, Nos. 10 and 11, 1881.

A New Apparatus destined to show the Dissociation of Ammoniacal Salts.—D. Tommasi.—This apparatus, the *dissocioscope*, is composed of a glass tube, 20 to 25 centimetres in length, by 3 or 4 centimetres in width. In the interior is suspended, by means of a platinum wire, a slip of blue litmus paper, previously steeped in a solution of ammonium chloride, which has been previously neutralised by the addition of a few drops of ammonia, avoiding excess. A cold saturated solution is required. The slip of litmus paper, after having been withdrawn from the liquid, is slightly pressed between two folds of blotting-paper, and is then suspended in the glass tube while still damp. To use the tube it is simply plunged into boiling water, when the paper at once becomes red. On plunging it again into cold water, it is rendered blue again.

New Method of Determining Gypsum in Wines.—E. Houdard.—Inserted in full.

Constitution of Complex Mineral Acids derived from Tungstic Acid.—D. Klein.—The author considers that in the hypothetic molecule, $5\text{H}_2\text{O}, 12\text{WO}_3 + x\text{Aq}$, there appear to be 8 hydroxyles which are only substitutable by bases, and 2 which can be indifferently substituted by basic residues, or by monatomic residues derived from poly-basic acids.

β -Chlorated Allyl-Chloride and some of its Derivatives.—P. van Romburgh.—Not suitable for abstraction.

Russian Chemical Society.—Session March 5/17, 1881.—M. Eremine examined the effects of the temperature of the voltaic arc upon barium and calcium sulphates. Barium sulphate is volatilised, and calcium sulphate is reduced to sulphide. A quantity of gas is produced, which, if passed into potassa lye, gives potassium nitrate and nitrite, whilst ozone escapes.

M. Boutlerow read a note by M. Gustavson on the transformation of the carbon chlorides into corresponding bromides. Also a new method of preparing solution of aluminium iodide in carbon disulphide.

The Secretary presented, on behalf of M. Kanonnikoff, a memoir on the influence of the structure of organic substances upon their power of refraction.

Also, on behalf of M. Karwowsky, a memoir on the results of the analysis of the excrements of bats, showing the absence of cupric compounds, and the analysis of an abscess extracted from the oviduct of a hen from Kokan.

Also, on behalf of M. Kartchewski, an analysis of mineral waters from Beresow.

M. Boutlerow gave an account of ice at the critical pressure.

M. Lubavine, presented, on behalf of M. Fedoroff, the exposition of a law relative to the values of the atomic weights of the elements. This law is expressed in the form of a table, where the elements are arranged in eight groups, and to each element is appended a number. To pass from these numbers to the approximate values of the atomic weights it is sufficient to raise each number to the 3-2 power, and to multiply the result obtained by 7-8ths. If the homogeneity and the likeness of the elements are admitted, we may conclude that the elements are ranged in the natural system in the increasing arithmetical progression of the surfaces of their atoms, and that the atomicity and the chemical properties of elements may be considered as essential functions of the same surfaces.

Tomie 36, No. 12.

Abnormal Development of Certain Planes in the Crystals of Citric Acid.—M. Ch. Cloëz.—The author gives the figures and measures of certain well-defined crystals deposited from a solution through which a current of chloride had been passed.

On Colloidal Tungstic Acid, and on its Analogy with Paratungstic Acid.—M. D. Klein.—Colloidal tungstic acid is known to possess a great stability, and is only converted into the insoluble acid at a temperature bordering upon dull redness. The author suggests that this colloidal acid may be formed by some unknown tungstic acid, probably the still unexamined paratungstic acid, $12\text{WO}_3, 5\text{H}_2\text{O}$.

Molecular Compound of Camphor and Aldehyd.—M. P. Cazeneuve.—Camphor shaken up with an aqueous solution of aldehyd, seizes hold of the latter, and is transformed into a liquid which floats upon the surface. The compound is dissociated at ordinary temperatures, leaving a residue of camphor.

Inversion of Sugar by Carbonic Acid.—M. E. Maumené.—M. von Lippmann has obtained 44° with carbonic acid under pressure. M. Maumené was the first to overturn the hypothesis of a division of inverted sugar into equal parts of glucose and chylarose (levulose). Inaose may be obtained by the action of equal weights of normal sugar and silver nitrate, both in concentrated solutions.

Rectification of Alcohols.—M. E. Maumené.—The author combats an assertion of M. Laurent Naudin, concerning his patent No. 86,636.

Determination of the Solid Extract of Wines.—M. E. Maumené.—The author considers that the results obtained by simple evaporation at 100° , are comparable and sufficiently exact for practical purposes.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 2, September and October, 1881.

This number contains no chemical matter save extracts from the *Comptes Rendus*, which have been duly noticed.

MISCELLANEOUS.

Importing Atmospheric Air.—A Berlin newspaper relates an amusing story of the famous German scientist, Alexander von Humboldt, who took advantage of the exemption from duty of the covering of articles free from duty, formerly the rule in France. In the year 1805 he and Gay-Lussac were in Paris engaged in their experiments on the compression of air. The two scientists found themselves in need of a large number of glass tubes. This article was exceedingly dear in France at the time, and the rate of import upon imported glass tubes was something alarming. Humboldt sent an order to Germany for the needed articles, and gave directions that the manufacturer should seal up the tubes at both ends, and put a label upon each tube with the words *Deutsche Luft* ("German air"). The air of Germany was an article upon which there was no duty, and the tubes were passed by the Custom officers without any demand, and arrived free of duty in the hands of the two experimenters.

MEETINGS FOR THE WEEK.

SATURDAY, 4th.—Physical, 3. "Further Experiments on the Discharge of Electricity by Heat," by Prof. F. Guthrie.
MONDAY, 6th.—London Institution, 5.
— Royal Institution, 5. General Monthly Meeting.
— Medical, 8.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
TUESDAY, 7th.—Institute of Civil Engineers, 8.
— Pathological, 8.30.
— Anthropological Institute, 8. "On the Aboriginal Inhabitants of the Andaman Islands," by Mr. E. H. Man.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.
WEDNESDAY, 8th.—Society of Arts, 8. "Improvements in Gas Illumination," by Prof. A. Vernon Harcourt, F.R.S.
— Geological, 8.
— Microscopical, 8.
— Medical (Anniversary), 8.30.
THURSDAY, 9th.—Royal, 4.30.
— Royal Institution, 3. "Geographical Distribution of Animals," by Dr. P. L. Sclater.
— London Institution, 7.
— Society of Arts, 8. "Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes," by W. K. Burton.
FRIDAY, 10th.—Royal Institution, 9. "Electric Lighting," by Mr. J. W. Swan, 9.
— Astronomical, 8.
— Quekett Microscopical Club, 8.
SATURDAY, 11th.—Royal Institution, 3. "The Iliad and Odyssey," by W. Watkiss Lloyd.

TO CORRESPONDENTS.

R. Burton.—1. The letters L.S.A. mean Licentiate of the Society of Apothecaries. 2. Your second question had better be addressed to the *Pharmaceutical Journal* or the *Lancet*. 3. It would be exceedingly indiscreet to give an estimate of the relative standing of the medical degrees granted at different colleges.

THE CHEMICAL

VOL. XLV. No. 1163.

VOLUMETRIC ESTIMATION OF ANTIMONY
IN THE PRESENCE OF TIN.

By E. F. HERROUN.

HAVING experienced considerable difficulty in obtaining even approximately accurate results by the usual methods for the analysis of alloys of antimony and tin, I tried the following process, and having found it successful I submit a short description of it to your readers, believing it to be as yet unknown.

This process is applicable to alloys such as Britannia metal or type metal, and depends upon the fact that antimonious chloride is reduced to antimonious chloride by hydriodic acid, with consequent liberation of iodine, whilst stannous chloride is unaltered.

The alloy, in a state of fine division, is dissolved in strong hydrochloric acid with the aid of heat, and with frequent additions of small quantities of potassic chlorate: after the whole of the metal is dissolved a small piece of potassic chlorate is added, to ensure the conversion of the antimonious chloride into antimonious chloride, and the solution gently boiled until all the oxides of chlorine have been expelled. The solution is then allowed to cool, and a slight excess of a strong solution of potassic iodide added. The free iodine is then estimated by means of a standard solution of sodic hyposulphite.

Since 122 parts of antimony liberate 254 parts of iodine, the amount of iodine found multiplied by 0.48031 will give the amount of antimony present.

If iron, or other metal whose perchloride is capable of liberating iodine, be present in the alloy, the tin and antimony may be obtained as oxides by treating the alloy with nitric acid and evaporating, and, after being well washed, may be boiled in strong hydrochloric acid, and the antimony determined as above.

THE ELECTROLYTIC DETERMINATION OF
COPPER.

In a paper read by Mr. J. B. Mackintosh, of Hoboken, N. J., before the Virginia meeting of the American Institute of Mining Engineers, he states that he had made a series of experiments with the Luckow electrolytic determination of copper. Mr. Mackintosh describes the manner in which he adapted the Luckow method to the analysis of copper alloys as follows:—

I dissolved the alloy in nitric acid, evaporated the solution to dryness to get rid of the excess of acid, dissolved the residue in water with the addition of a few drops of nitric acid to dissolve the basic nitrate of copper formed, and to this solution added 4 or 5 drops of a concentrated solution of citric acid. This solution was then precipitated in a platinum dish with a current from two Bunsen cells of about one quart capacity. In precipitating several samples at once, I have it arranged so that the whole current traverses the row of dishes, the negative pole of each set being connected with the positive pole of the next succeeding one. In this case, if n be the number of dishes, then $n+1$ is the number of battery-cells of that size used. Some of the results obtained by this method, and on duplicate portions by precipitation from sulphuric acid solution, are as follows:—

	Sulphuric Acid.	Nitric+Citric Acid.	Error.
1 grm. pig-copper ..	98.00	99.42	+1.42
" ..	99.80	101.22	+1.42
" ..	98.92	100.41	+1.49
" ..	98.72	100.27	+1.55
" ..	99.60	100.45	+0.85
1 grm. brass ..	65.83	66.93	+1.10
" ..	65.83	66.58	+0.75

In only one case was a smaller percentage obtained by the use of this method; and in that case, the precipitation of the copper was not complete. In many cases, also, in which the amount of error was less than 1 per cent, small quantities of copper escaped precipitation, and were afterward found in the solution.

Mr. Mackintosh has followed up the matter, analysing the copper deposited, in which he determined carbon, hydrogen, and nitrogen; and he reaches the conclusion that some organic matters, and in all probability all, in the presence of nitric acid in the copper solution undergoing electrolysis, cause erroneous results; that from a nitric acid solution, with no organic matter, it is extremely difficult to separate all the copper; and that the old method of electrolysis from the sulphate is the best.

Mr. C. Luckow has taken up the matter in the *Chemiker Zeitung*, in which he states that he added tartaric acid to the nitric solution of copper only with the special purpose of preventing the injurious action of manganese salts when present, with special reference to the assay of the Mansfeld copper slates. He states also that the form of the apparatus was designed with that object in view. He advises that tartaric acid be dispensed with, except when small quantities of manganese are present, and says it is easy to deposit the copper from the solution holding free nitric acid, if care be taken to drive off nitrous acid, and not to use too strong a current.—*Engineering and Mining Journal*.

THE OCCURRENCE OF OPALS IN CENTRAL
AUSTRALIA AND QUEENSLAND.*

By JAMES R. M. ROBERTSON, M.D., F.G.S., F.R.G.S.

(Concluded from p. 97.)

THE comparatively small area, within which opals of commercial value—that is, in respect to quantity, colour, and thickness—have been found, consists of castellated sandstone hills of curious configuration. I have attempted to delineate in a sketch the physical features of the two hills, under which the best opals have been found. These hills with their mines or openings will hereafter be designated "Aladdin." As in certain localities, minerals occur in certain distinctive forms, so each locality that I have named can at once be distinguished by the characteristic form of its opals.

Instead of the thin, thread-like, or scaly patches that are found in the liver-coloured matrix of the Bulloo, or the Barcool country, it is found in the Aladdin hills in all its most valuable and lovely forms as precious opal, as fire opal (or girasol), as common opal, as wood opal, and as hyalite. At Aladdin, it is found under the following conditions:—

First. Masses of laminated ferruginous silica of some thickness are found embedded among the gritty sandstone beds, and these masses are occasionally divided into squares by comparatively wide fissures. When broken, some of these pieces are found coated with a layer of opal from one-eighth to one-fourth of an inch thick. The opal is arranged in bands of brilliant emerald green, or bluish green, yellow, or red. I show you in Specimens No. 7, two large pieces, coated with opal on three sides, which for beauty can scarcely be surpassed.

* Paper read before the Glasgow Geological Society and Chemical Section of the Philosophical Society, January 23rd, 1882.

Second. In the country immediately adjoining Aladdin Hills large quantities of opaque opal or *calcedony* is found. Nearer Aladdin this variety is found in a more refined and translucent form, showing a little colour, as in specimen No. 2.

The Aladdin opal is found on the slopes of the two hills referred to. These hills rise out of a level, grassy, or scrubby plain. The slopes are composed of loose, decaying pieces of soft sandstone. They have an angle of 45°. The top is a concretionary mass of gritty, loosely aggregated sandstone, full of adventitious or accessory pebbles and minute holes. The colour is reddish or mottled, and is due to the permeation of ferruginous water. The crests are redder than the underlying portions, and resemble badly burnt brick in appearance and consistency. The top of one of the hills is circular, the other is elliptical, and is several hundred feet in length. The crests are divided by vertical joints formed during consolidation, and have broken off by these, forming the perpendicular walls, and produce the castellated appearance referred to. The strata underlying the crests is composed of soft, grey, or yellow earthy layers, closely resembling bath-brick, obscurely bedded, difficult to correlate, broken up by vertical joints, and held together by irregular strings of ferruginous sandstone.

Third. At intervals, soft and somewhat irregular or strangulated beds of steel grey or chalky earth, about eight inches thick, separates these beds; and embedded in this chalky earth, flattened nodules or lenticular masses of what I supposed at first sight were ironstone are found. These nodules are of very uniform size and shape, about 10" x 6" x 5". They are found lying on their flat side. As these nodular masses are the principal source of opals, I would desire to describe them somewhat in detail. (The author exhibited diagrams.) These nodules consist of an external crust or shell, the thickness varying from ¼" to 1". This shell is built up of a number of thin concentric layers of ferruginous silica, separated by fine lines of a light yellow colour. On being broken these concentric layers are seen in section to enclose a siliceous, somewhat splintery, cream-coloured kernel that completely fills the shell. These kernels are the *real* matrix of the opal. During the process of drying and consolidation, cracks and cavities have formed, separating parts of the kernel from the shell, but invariably reticulated throughout the mass of the kernel. In the same manner, septaria (fissures and spaces) have formed in the substance of the hard shell, seldom, however, penetrating through all the layers. These vermiform crevices, or septaria, have subsequently become filled with a plastic or gelatinous solution or silica, which has become opal; the quality evidently being dependent on the degree of compression, or the variety and amount of the colouring absorbed, and the presence of other conditions to which I will afterwards allude. I have remarked that the nodules are found lying on one of their flattened sides. Now the thickest and best opals occur as a rule (but not invariably) on the lower surfaces, where from gravity you would suppose a fluid would accumulate. The crevices or septaria occurring in the shell frequently exhibit opal that emits rays of blood-red or emerald-green colour. Where the particles composing the shell have been loosely aggregated, silica has been absorbed, and the substance of the shell itself has become opalised.

The question naturally arises from whence, and in what manner, were these nodules formed? Arranged as the shell is in layers similar to an agate, one is inclined to think that their origin is due to the infiltration of siliceous water into a cavity, but the similarity in form and size, and arrangement in beds, of these nodules oppose certain difficulties. If we adopt this view, we must account for the white kernel within the shells.

If the shells have *not* been formed within a cavity (and I am inclined to think they have not), they may possibly owe their origin to segregation alone. The kernel is composed of material more compact and siliceous, and

contains less iron than the superincumbent strata. If one could imagine the iron or colouring matter abstracted from that strata while the mass was in solution, the resultant would, I think, present an appearance very much akin to these kernels. As to which of these causes, if any, their origin may be due I am not prepared to say; but I have laid out several forms of these models for your inspection, along with about 110 illustrative specimens, as I took them from the mine, that you may be enabled to form some independent opinion on the subject.

To my mind, the origin of the opal itself is not veiled in so much obscurity. On minute examination, I found that the soft, earthy, superincumbent beds contained curious vertical rod of ferruginous silica, similar to the shells of the nodules. These rods appear to lead from the layers of nodules up through the superincumbent rocks. On breaking one of these rods out, I found that in reality it was a pipe containing, within siliceous walls, a small round channel. I show you such a pipe, No. 13. The first of these that I picked out were either empty or contained a little powdery earth; and I at once recognised in them a clue to the formation of the opal, if not the nodules themselves. While prosecuting my investigations among the shattered fragments of a recently fallen cliff, I came upon additional bits of these fractured pipes, with the channels filled with opal. I have laid out several fragments of these pipes with the channels filled with opal cores (No. 12). One or two of these cores in specimen No. 19 display throughout their whole body the wonderful and delicate play of colours characteristic of the oriental opal. There can, I think, be little room to doubt that the matter that formed the opals in the kernels described was conveyed down through the mass of rock by means of these pipes; but whether these fulfilled the double purpose of conveying down the substance of the nodules themselves as well as the opal, and whether these were synchronous or separated by a period of time must be left for future investigation.

So far as I could discover, there are several layers of these nodules underlying—interstratified, if you will, with sandstone—the Aladdin Hills. These beds or layers are separated from each other, by several vertical feet of strata. The nodules are not all uniformly charged with opal, some are of little value; others contain opal of great value. The most valuable stones are broken by the act of smashing the nodules. As there are no outward signs by which the opal value of the nodules can be determined, each should in future be sawn across in order to discover the quantity and quality of the contained gem. To the right of Diagram No. 3 is an enlarged section of a nodule, shewing the mode in which opal is found within its kernel. The pipe that I have sketched must be considered imaginary, as I have not been able to trace such a clear connection as is here shown. Those of you who know the sequence of the chalk formation will recognise in the occurrence of these nodules a close analogy with the layers of flints found in some districts where chalk is found.

Fourth. I have on more than one occasion remarked that the crests of these hills assumed a castellated or turret form, and were composed of gritty, ferruginous particles of brick-like consistency and colour, and that it was somewhat porous. It has all the appearance of having been subjected to heat, and given passage to heated gases. In examining this sandstone I found the remains of pipes, or vertical channels, with obscurely defined walls, filled with common and precious opal, or opal having a burnt, waxy, vitreous appearance. Opal is found in this sandstone, occupying holes or cavities, or filling up portions of the mass, where the sand has been loosely impacted. Portions of the substance of the sandstone have, in fact, become opalised. You will find specimens in the table illustrating this condition.

In the gritty, brick-like crest, opal is found of beautiful colour, in irregular shoots, among the matrix; or permeating the substance of the matrix.

So far, the result of my investigations go to prove that the origin of opal is due to the infiltration of opal forming material (siliceous waters) from above; and that the subsequent elaboration, or the formative process, has been encouraged under conditions of pressure and heat; both of which I believe to be favourable, if not necessary, for the solution, separation, and ultimate crystallisation of the silica, that in so large a measure forms the opal.

These latter conditions I have not established so fully as I would desire; but this I can say, that the two Aladdin Hills are separated from each other, and are situated between three broad intrusive dykes of compact grey and vitreous *Felsite*; further; that the indurated clays are burnt in places, and bear evidence of having been subjected to a high temperature; that portion of the sandstone bears similar evidence; and that the finest quality of opal is, as a rule, found within a reasonable distance of these "Dykes."

Nor have I been able to determine whether or not the gem exists in like conditions under the level of the surface. There can, however, be no doubt that from all these sources large quantities of opal will be obtained.

Whatever the extent of the resources in depth, or the exact conditions favourable or necessary for the development or formation of the opal, all evidence seems to point to the localisation of these conditions. In other words—that valuable deposits of opal are not widely distributed.

I have stated that the occurrence of these nodular masses inclined me to the belief that their origin was due to segregation; and that it was probable that the opal found in the septaria, or filling the fissures of these nodules, was due to infiltration. I wish you to clearly understand that this is only an opinion; I cannot say that I have established it, even to my own satisfaction. My opinion is based upon finding opal in various forms, within the channels of the vertical pipes, as may be seen in the several specimens laid out for your inspection. It may be held by some of your number that opal, as well as the "casing," or shell of the kernel, have all been formed by segregation; and that the pipes are due to the same cause. Dual segregation in the one case, and the fact that the channel within the pipes are sometimes empty, present to my mind certain difficulties to the acceptance of such a cause. Still, I am not prepared to negative it. It may be permissible to say a few words upon the nature and origin of the material that has (by subsequent agencies) been converted into opal. It is very probable that the material was derived from above, and from the rocks in which it occurs. Opal, as you are no doubt aware, is an amorphous and one of the many forms of quartz. Roughly speaking, it is composed of 92 of silica and 8 of water, with certain colouring agents. You may consider opal as a solidified mass of gelatinous silica, in which the proportion of silica and water varies. You may recollect that when describing the nature and colour of the rocks composing the hill ranges, that I remarked that the surface of the rocks was occasionally coated by an efflorescence of magnesia salts. It is probable that the constituents necessary for the formation of opal may be obtained from the decomposition of the silicate of magnesia by carbonic acid. Causes that would at first sight appear to be trivial and unimportant are often sufficient to cause to pass from one condition to another—from the amorphous to the crystalline state. The presence of carbonate of ammonia would be sufficient (under certain conditions of silica) to precipitate silica and alumina; and ammonia may be produced by the presence of some nitrogenous organic substance in the solution of silica. You are probably all aware that many of the forms of silica do contain organic substance, and this is proved by the change of colour that they undergo when subjected to heat. Chalcedony, rose quartz, carnelian, and smoky topaz, are examples of this condition. Probably the reason why opal is an amorphous and not in a crystalline form (of quartz) is because of the presence in it of iron or manganese.

The amount of water contained in opal varies consider-

ably—from 3 per cent. to 10 per cent. Opal differs from quartz in having a lower specific gravity and an inferior degree of hardness in refraction, and of course in chemical properties. The beautiful combination and play of colours exhibited by opals are probably due to the colouring ingredient present, and these may be influenced by the presence of some invisible flaws. The colours are intensified by heat and light.

Some observers affirm that the distinct bands of some varieties of opals are caused by infusoria, and that the red fire of the noble opal is caused by the presence of minute particles of quartz.

In Hungary and elsewhere where opal is found, the gem is found in trachyte, and is considered as the result of the decomposition of that rock. The presence of siliceous rocks may be considered as essential to the formation of opal, and, like all mineral substances derived from adjoining rocks, it bears a definite relation to the constituents of the rocks, from whence, by decomposition, it was derived.

Dr Dobbie, of this Society, has very kindly furnished me with an analysis of the Opal of Aladdin, of the ferruginous crust of the nodules, of the white matrix or kernel within this crust, of the rock in which these are formed, and these are as follows:—

I. Opal.

	Per cent.
Water	6.43
Silica	93.57
	100.00

II. White Kernel.

Sesquioxide of iron	2.15
Sesquioxide of alumina	30.94
Silica	67.31
	100.40

III. Ferruginous crust of Nodule.

Silica	35.89
Sesquioxide of alumina	2.99
" iron	47.72
Protoxide of iron	3.55
Lime	0.46
Magnesia	0.55
Water	—
	100.00

IV. Sandstone of Hill.

Silica	65.94
Sesquioxide of alumina	13.54
" iron	14.04
Lime	1.03
Carbonic acid	0.37
Water	1.03
Alkalies by difference	3.88
	100.00

In the flats immediately surrounding these remarkable hills are several circular mounds, evidently marking the site of other conical hills, slowly settling down, under the influence of the climate; the earthy portion has all been washed away into the plains; the ferruginous nodules have been broken up by the powerful rays of the sun, the rains, and the winter frosts. Amid the wreck of material one has no difficulty in picking up pieces of opal weathered by the sun-rays of a thousand summers; and bushels of matrix, or shells, may be gathered with the substance a network of brilliant green threads of opal, which when cut and polished might be utilised as buttons, or breastpins, or for inlaying, or in other useful ways.

I have taken up much of your time, and probably have succeeded in exhausting as much of your patience, in describing

the details of the occurrence of opal in Central Australia. My apology for so doing rests in the circumstance that I have not been able to discover any work in which the occurrence of these gems are minutely described. Dana states that in Hungary, Bohemia, Saxony, Mexico, Iceland, opals are found, and that in these countries they are "found filling the cavities or the seams of igneous rocks, or (like other quartz concretions) embedded in flint and limestone." The description is certainly vague, and he might have added Brazil, were it occurs in connection with transmuted limestone, or in crevices of altered chalk. So far as I can discover, Australian opals will in the future be more heard of. They occur under totally different conditions to those he alludes to, and to all appearance in quantities that should the gem become as popular as from the beauty of its hues it deserves, these lonely wilds of Central Australia will be the scene of an industry, as lucrative as it is novel.

The recollection of the magnificent view from the top of the Aladdin hills comes back as a green and pleasant reminiscence of a long and wearisome journey. Though there is no soil on the top, a few stunted honeysuckles and hardy flowering plants have struggled into existence to "waste their fragrance on the desert air." Among these we sit to scan the illimitable landscape and to watch the sun set in an atmosphere of roseate glory. We see the light stealing over the plain, colouring the scrub and illuminating the curiously shaped hills with golden hues. It vanishes from the plains, to play among the lesser hills; wonderful effects of light and shade are visible. Mounting upwards, bands of coloured rays are projected against the crests of the higher peaks that shine for a moment like burnished gold. While yet the soft and short twilight of these regions lingers on the mountain slopes, and the valleys are in partial darkness, we seek the genial warmth of the camp fires and the comfort of the "cup that cheers, but not inebriates," and rolled up in our blankets, we fall asleep under—may I say—the shadow of the Southern cross. At an early hour we had turned our back on these quiet and sunny scenes, and with our saddle bags heavily laden with the spoils of the Aladdin hills we jog steadily back on our long journey of well nigh a thousand miles towards Brisbane and the rising sun, meditating all the while on a further journey of 13,000 miles through the land of the "Spread Eagle" towards home and friends. I did not at that time anticipate that I should so soon after my arrival have the felicity of appearing before the members of this society, to dilate (as I have done) at no considerable length, on the physical geography of part of "Greater Britain"—the land of the Wallaby and the Kangaroo—and the geological aspects of the opal country of Central Australia.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 2, 1882.

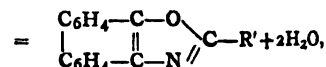
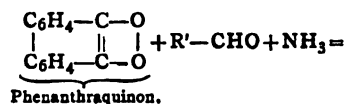
Prof. H. E. Roscoe, President, in the Chair.

THE following certificates were read for the first time:—J. H. Beckett, E. G. Love, A. M. Palmer, W. H. A. Peake, J. Robinson, and J. H. Stebbins.

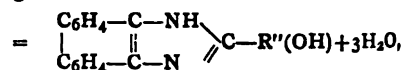
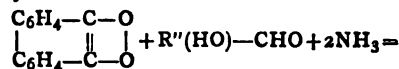
The following gentlemen were elected Auditors for the year:—Messrs. D. Howard, A. J. Greenaway, and D. L. T. Thorne.

The PRESIDENT then called on Dr. JAPP to read a paper "On the Action of Aldehyds on Phenanthraquinon in presence of Ammonia" (Third Notice), by F. R. JAPP and F. W. STREATFEILD. In a previous paper it was mentioned that by the action of salicyl-aldehyd and ammonia on phenanthraquinon a compound, $C_{21}H_{14}N_2O$, was obtained. The present paper is devoted to a further study

of compounds obtained by acting upon phenanthraquinon in the presence of ammonia with hydroxy-aldehyds and with a methoxy-aldehyd. The properties and reactions of the various compounds obtained are given in detail in the paper. The general results may be summed up as follows:—The reaction varies with the nature of the aldehyd employed. 1. With aldehyds of the benzene series the reaction takes place thus:—



in which R' represents a monad radical of the phenyl series. Furfur-aldehyd acts also like an aldehyd of the benzene series. The compounds formed belong to the class of substances which were obtained by Ladenburg (*Ber.*, ix., 1524), in which a triad radicle, of the form $R'-C\equiv$, replaces the three atoms of hydrogen in the amidogen and hydroxyl groups of ortho-amido-phenol. 2. When hydroxy-aldehyds of the benzene series are employed the reaction is—



the compound formed belonging to the class of the anhydro-bases described by Hübner. 3. With a methoxy-aldehyd (the reaction of the methyl ether of salicyl-aldehyd has alone been studied) both the above reactions take place simultaneously, and a mixture of the two compounds above mentioned is accordingly obtained. The above reactions, which may be regarded as condensations in the ortho-series, are most readily accounted for on the assumption that phenanthraquinon possesses the peroxide constitution ascribed to it by Graebe. The actions of ammoniac formate upon phenanthraquinon, and of acetone and ammonia upon phenanthraquinon, are being investigated.

Dr. JAPP then read a second paper, "On the Application of the Aldehyd and Ammonia Reaction in determining the Constitution of Quinons," by F. R. JAPP and F. W. STREATFEILD. As the reaction described in the previous paper probably belongs to the class of condensations in the ortho-series, it ought not to occur with paraquinons, and may therefore be used as a test of the ortho-position in quinon. Chrysoquinon and β -naphthaquinon were thus noted. Chrysoquinon proved to be an orthoquinon; the second body yielded only a negative result.

Mr. R. COWPER then read a paper "On the Solubility of Glass in Certain Reagents." Ammonium sulphide was the first reagent, the action of which was investigated: 100 c.c. of the ammonia, sp. gr. 0.880, from which the ammonium sulphide was prepared in the usual way, left 0.0015 grm. residue. The other reagent was ammonium hydrate. A measured quantity of the reagent was sealed up in a tube of hard Bohemian glass, and kept at 100° C. for six days. The liquid was then poured out, neutralised with HCl, evaporated, and the residue ignited. The following table gives the results obtained:—

Reagent.	M. grms. dissolved by 100 c.c.	
H ₂ O	8.0	10.0
H ₂ S	12.5	8.7
Dilute Am ₂ S (from AmHO 0.982) ..	49.6	52.5
Strong Am ₂ S (from AmHO 0.880) ..	34.0	47.2
Dilute AmHO 0.982	25.8	42.5
Strong AmHO 0.880	7.5	7.7
AmHS (from AmHO 0.982)	—	51.2

It will be seen that the dilute solution of AmHO and Am₂S have a very marked solvent action on glass.

Mr. R. COWPER then read a second paper, "On the Analysis of a Piece of Oxidised Iron from the Condenser of H.M.S. Spartan." The specimen consisted of a brownish substance, with many shining black particles, and resembled a piece of rusty grey pig-iron. Its sp. gr. was 2.63; it was very friable. Details are given of the quantitative analysis, which yielded the following result:—

Insoluble residue 31.84	Carbon ..	12.57	
	Hydrogen ..	0.24	
	Incombustible 17.54		SiO ₂ 16.98
			Fe ₂ O ₃ 0.12
Cupric oxide ..	0.38		Al ₂ O ₃ 0.06
Ferric oxide ..	2.21		CaO 0.15
Ferrous oxide ..	42.33		MgO 0.02
Alumina ..	0.16		
Manganic oxide ..	1.02		
Cobalt oxide ..	0.05		
Sodium oxide ..	0.11		
Phosphoric acid ..	5.24		
Sulphuric acid ..	0.31		
Chlorine ..	2.08		
Vanadic acid ..	0.11		
Water ..	16.71		
102.55			

The points of interest, are that there was not a trace of metallic iron, a great preponderance of ferrous over ferric oxide, and a comparatively large proportion of chlorine in combination with iron and manganese. Ordinary cast-iron rust contained 65.4 per cent Fe₂O₃ and 7.42 per cent FeO. A somewhat similar preponderance of FeO is given in an analysis of oxidised iron from the blade of a screw-propeller, by Liversidge (*Proc. R. S. of New S. Wales*).

The PRESIDENT believed that a somewhat similar oxidation of iron was mentioned in Percy's "Metallurgy," in the case of an iron pump at the bottom of a coal-pit.

Dr. DEBUS mentioned the conditions under which the oxidation had taken place: the iron formed part of a box through which ran a copper pipe. He then recapitulated the points of interest in the paper, and especially drew attention to the large amount of ferrous oxide.

Dr. DUFFRÉ suggested that the rapid oxidation was caused by a galvanic action of the iron and copper, rather than by the rusting of iron in sea-water.

Dr. DEBUS disagreed entirely with the suggestion of the last speaker.

The SECRETARY then read a communication "On the Action of Sodium Hydrate and Carbonate on Felspars and Wollastonite," by W. FLIGHT. The author has made many quantitative experiments on this subject. Thus a specimen of Adularia felspar was dried at 120°, and digested, with about 3½ times its weight of sodium hydrate in strong solution, for twenty-five hours, at 100°, in a platinum vessel; 35.688 per cent of the Adularia was rendered soluble. The general result at which he arrives is that sodium hydrate acts powerfully as a solvent upon these silicates, but that the strongest sodium carbonate has but a slight action. The author also proves that the action of sodium hydrate is simply that of a solvent.

The SECRETARY read a second paper by Dr. FLIGHT, "On the Preparation of Pure Nitrogen." The author was quite unable to remove the last traces of oxygen from atmospheric air, either with phosphorus, potassium pyrogallate, hyposulphites, an alloy of 2 parts of potassium and 1 part of sodium or metallic copper at a red-heat. In all cases the nitrogen contained oxygen, and developed a brown colour in potassium pyrogallate. He was able, however, to remove the oxygen completely by passing the gas over a large surface of ferrous hydrate freshly precipitated, by adding a strong solution of 80 grms. of caustic potash, to a solution of 200 grms. of ferrous sulphate.

Mr. W. H. PERKIN then read a paper entitled "Some

Observations on the Luminous Incomplete Combustion of Ether and other Organic Substances." The author observed, when evaporating ether in a shallow vessel on a strongly heated sand-bath, on a dark evening, that a pale blue flame was floating about the surface of the sand. On referring to Gmelin's Handbook he found that this phenomenon had been observed by Sir H. Davy. Döbereiner and Boutigny have also put on record similar observations. In the present paper the author has pursued the investigation somewhat further, in order to produce the effect on a sufficiently large scale for lecture purposes. It can be shown by directing a jet of ether (preferably containing from 5 to 10 per cent of alcohol) from a wash-bottle on to a thick iron dish heated nearly to dull redness. Ether enters into this luminous incomplete combustion about 260° C., much irritating vapour being produced: the temperature of the flame is so low that it does not char paper or inflame carbon disulphide. If the flame be confined, as by a paper chimney, the temperature soon rises, and the ether enters into ordinary combustion. Another very effective method of exhibiting this blue flame is to suspend an iron ball, heated nearly to a dull red-heat, over a dish containing filter paper moistened with ether, when a lambent blue flame surrounds the ball. In all cases a dark room is necessary. Spermaceti thrown on to a heated iron ball gives a similar result. Olive oil, linseed oil, white wax, paraffin, stearic acid, oleic acid, and acetic aldehyde gave blue flames when heated. Methyl and ethyl alcohols and propionic acid also gave a feeble reaction. Benzene, toluene, naphthalin, anthracen, formic acid, acetic acid, benzoic acid, cinnamic acid, and phthalic acid gave no result. The phenomenon is probably analogous to that observed at ordinary temperatures with phosphorus. The author demonstrated with complete success the blue flame obtained as above described with ether and spermaceti.

The Society then adjourned to March 16th, when the following paper will be read:—"On Valency," by Dr. Armstrong. The undermentioned papers are also announced:—"On Pentathionic Acid," by Watson Smith and T. Takamatsu; "On some Constituents of Resin Spirit," by G. H. Morris; "On the Preparation of Diethyl-naphthylamin, and on the Action of Sulphuric Acid on that Substance," by B. Smith.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, January 26, 1882.

Mr. I. LOWTHIAN BELL, F.R.S., Vice-President, in the Chair.

THE minutes of last meeting were read and confirmed.

Dr. H. S. Pattinson was elected a member of the Society.

The following nominations were made:—Mr. J. R. Young, Dr. Rudolph Messel, Mr. A. J. Smith, Mr. C. E. Stuart, B.Sc.

"Experiments with Alloys of Lead, Copper, and Antimony, to Determine their Value and Fitness in the Erection of Sulphuric Acid Chambers," by JOHN GLOVER.

From time to time there has appeared, both in foreign and English publications, an account of experiments on the action of sulphuric acid on alloys of lead and antimony.

The results of such experiments, I believe, showed that a small percentage of antimony lessened the destructive action of the acids.

A small percentage of copper, when alloyed with lead, was also said to have a similar effect.

As all the experiments, so far as I am aware, were made by heating the acid and the alloy together, and noticing the loss, it occurred to me that any inference drawn from such experiments as to the benefits to be derived from the use of such alloys in the construction of sulphuric acid chambers might be misleading, seeing that the

chemical conditions and consequent reactions are very different in a chamber from those existing in a concentrating pan. To test this idea, Mr. Norman Cookson, one of our members, very kindly prepared the alloys used in the following experiments, and rolled them into sheets of about 7 lbs. per foot in his excellent rolling mills, under the same conditions as sheet lead is generally rolled.

Portions of these sheets, of such sizes as permitted their being weighed on a balance turning with 1-50th of a grain, were hung in a chamber, being the first in a series, at a distance of 30 feet from the inlet, 1 foot 6 inches from the top, equidistant from the sides, and within a few inches of each other.

The chamber was worked in all respects as chambers are usually worked when Spanish pyrites and towers are used. The samples were all put into the chamber together on September 22, 1880, and taken out together on January 10, 1881, a period of 110 days.

The line marked A in the accompanying table shows the effect on a piece of sheet lead made with the same lead as that used in the alloys, and exposed to exactly the same conditions as to time, place, and chemical action.

A Unalloyed Lead, 7.5 per cent Loss.			
Alloy of Copper.		Alloy of Antimony.	
Per cent of Copper.	Loss Per cent.	Per cent of Antimony.	Loss Per cent.
0.1	7.1	0.1	8.1
0.2	7.1	0.2	9.2
0.3	7.5	0.3	10.9
0.4	9.1	0.4	11.6
0.5	8.5	0.5	11.9
0.75	8.7	—	—

The percentage amounts of copper and antimony were determined by synthesis, pure antimony being used. Mr. Cookson had some difficulty in making the alloy with copper, which may account for some discrepancy in that column. The inference deducible from these experiments is that such alloys are not to be recommended for sulphuric acid chambers.

Mr. COOKSON—In reference to Mr. Glover's paper, I should like to point out that there is a very wide difference between acid conditions and chamber conditions. Knowing that Mr. Glover was going to bring the results of his experiments before the Society to-night, I thought it might be interesting to add to his remarks some results which have been obtained by Mr. Sanderson and myself in regard to alloys of lead and antimony. Mr. Glover's experiments were carried out under chamber conditions, ours under acid conditions. We took commercially pure lead, and alloys of the same lead with 0.1, 0.3, 0.5, and 1.0 per cent of antimony, and heated them for different periods in acids of different strengths, determining in each case the loss which the plate sustained. The samples were all as nearly the same size as possible, the difference in weight being caused by the unavoidable slight difference in thickness. The surfaces presented were identical. The table below shows the results.

It will be seen that in the strong acid the effect of the antimony is very bad; with the weaker acid it is not very perceptible. For my own part, I think the standing of the lead is to a great extent a physical question, and depends on the condition of the lead rather than its composition. A short time ago we sent some lead to a manu-

facturer, who used it for concentrating pans, and he complained that after a very few hours' use the lead was nearly half eaten away. On examining the lead we found that it had gone in lines parallel to the direction of rolling. Analysis showed it to be commercially pure lead. We then took plates of this lead, and of another lead which was said to have stood excellently in the concentrating pans, rolled them under the same conditions, and sent them to Mr. Glover without telling him their history, and asked him to hang them in his chambers with his other plates. A similar pair was hung in our own chambers; in both cases the lead which had been complained of for concentrating pans stood very much the best.

Mr. JOHN PATTINSON—It appears from the experiments, both of Mr. Glover and Mr. Cookson, that no advantage, from a chemical point of view, is derived by the addition of antimony to lead. I should like to ask whether it is beneficial in any other respect—in increasing the mechanical strength of the lead, for instance?

Mr. COOKSON—The alloys with antimony are harder, and will bear a greater tensile stress than pure lead; for instance, they are extremely useful for the vessels from which the acid is forced up to the Glover towers.

The CHAIRMAN—It seems that pure lead is still the most suitable material for chambers, and that the addition of antimony does not at all improve it for that purpose. I should just like to suggest, with regard to the small irregularities in the action of acid on copper-lead alloys, as shown in Mr. Glover's table, that possibly the samples from which the analyses were made might not be altogether fair representations of the composition of the plates. We know that in the case of many alloys a re-distribution goes on during cooling before solidification, which causes different portions of the mass to vary slightly in composition, and it is possible that this may be the case with these alloys.

"On the 'Albo-Carbon Light,'" by JOHN PATTINSON, F.I.C., F.C.S.

The "Albo-carbon Light" is the name given to the light produced by the burning of ordinary lighting gas enriched by the vapour of naphthalen. Naphthalen ($C_{10}H_8$) is obtained by the distillation of the heavy oils from coal-tar. At ordinary temperatures it is solid, and when quite pure it is white, but, as usually obtained for use in the "Albo-carbon" lamp, it is of a brownish white colour. It melts when heated to about $174^{\circ} F.$, and boils at about $420^{\circ} F.$ It probably exists in small quantities in all ordinary coal-gas, and occasionally causes a good deal of trouble, especially in cold weather, by condensing in the gas-pipes and preventing the free passage of gas. In the "Albo-carbon" apparatus the naphthalen is placed in a spherical vessel to which a tongue of copper is attached which projects over the flame and conveys heat to the spherical vessel and its contents. The naphthalen is thus melted and vapourised. The ordinary gas is led into the spherical vessel, through which it passes on its way to the burner, carrying with it the naphthalen vapour. The lamps are made of various patterns, and have one, two, four, six, or eight burners. They are the invention of Messrs. Kidd. The "Albo-carbon Light" was exhibited at the Newcastle Meeting of the British Association of Gas Managers in 1879, but since that time it has been much improved.

I have recently had occasion to examine one of the new "Albo-carbon" lamps for Messrs. Bainbridge and Co., of

	Four Hours' Boiling in Strong Acid.		Eight Hours in Acid, $143^{\circ} T.$, at $390^{\circ} F.$		Twelve Hours in Acid, $111^{\circ} T.$, at $310^{\circ} F.$		Sixty Hours in Acid, $111^{\circ} T.$, and about $120^{\circ} F.$	
	Weight. Grs.	Loss. Grs.	Weight. Grs.	Loss. Grs.	Weight. Grs.	Loss. Grs.	Weight. Grs.	Loss. Grs.
Lead from which mixtures were made	338.06	14.526	322.874	6.164	323.376	0.502	323.534	0.158
Containing 0.1 per cent antimony ..	389.58	17.542	371.45	8.23	371.93	0.48	372.038	0.108
" 0.3 " ..	410.33	24.052	385.572	14.072	386.132	0.56	386.278	0.146
" 0.5 " ..	419.73	34.68	384.512	25.822	384.99	0.478	385.05	0.06
" 1.0 " ..	441.538	39.758	401.22	29.632	401.704	0.484	401.78	0.076

Newcastle, and through their courtesy I am enabled to make known the results I have obtained. As the "Albo-carbon Light" is coming into use in several places in Newcastle and elsewhere, I have thought that these results would be of interest to many of the members of this Society.

The form of lamp experimented with was one with a single burner. The burners used in all the lamps are small union-jet burners (Bray's No. 1), altogether unsuitable for burning common coal-gas, but found to be most suitable to burn the enriched gas.

In order to determine the quantities of gas and naphthalen used per hour when the maximum amount of light was yielded that the burner was capable of giving without causing a smoky flame, the lamp was first weighed after it was heated, and when the vapour of naphthalen was coming off freely; the flame was then allowed to burn for one hour, during which time ten determinations of the illuminating power were taken at regular intervals; the lamp was then again weighed, and the difference between the two weighings gave the amount of naphthalen used in one hour. The amount of gas used at the same time was carefully measured by a meter.

It was thus found that the average light yielded during the hour was equal to 24 standard sperm candles, and that this was produced by the consumption of 3.7 cubic feet of common coal-gas of 16 candle-power and 120 grs. of naphthalen, or "Albo-carbon," as it is called.

Calculating these results to the usual standard of 5 cubic feet, the illuminating power of the ordinary gas is thus raised so as to produce a light equal to 32.41 sperm candles per 5 cubic feet of gas used, or to the illuminating power of very good canal coal-gas.

Let us now consider how much common gas alone would be required to yield the same amount of light. This depends in a great measure on the kind of burner used. Many flat-flame burners in very common use will not yield more than 10 candles' light when burning at the rate of 5 cubic feet per hour. Other flat-flame burners when using larger quantities of gas per hour will yield a light equal to about 17 candles per 5 cubic feet of gas, whilst in good argand burners a light equal to 18 or 20 candles per 5 feet of gas used can be obtained. For the sake of comparison, however, let us assume that the ordinary gas is consumed in flat-flame burners which yield a light equal to 12 candles per 5 cubic feet, and this will not be far from the average yield of the gas when fairly good flat-flame burners are used. Two such burners would be required to yield a light equal to 24 candles, and they would consume together 10 cubic feet of gas per hour.

The price of gas in Newcastle, after deducting the usual discount for cash, is at present 2s. 0½d. per 1000 cubic feet. The price of "Albo-carbon" is 6d. per lb., or, when sold in large quantities, 40s. per cwt.

Taking these data it will be found that in order to enrich with "Albo-carbon" 1000 cubic feet of gas so as to produce a light equal to 24 candles when burnt at the above-named rate, 4.63 lbs. of "Albo-carbon" will be required. The cost of 1000 feet of enriched gas, taking "Albo-carbon" at 6d. per lb., is as follows:—

	s.	d.
1000 feet of gas	2	0½
4.63 lbs. of "Albo-carbon"	2	3½
	4	4

Taking "Albo-carbon" at 40s. per cwt., the cost is as follows:—

	s.	d.
1000 feet of gas	2	0½
4.63 lbs. of "Albo-carbon"	1	7½
	3	8

These quantities would give a light equal to 24 candles for 270 hours.

In order to produce the same amount of light for the same length of time from ordinary gas when fairly good

flat-flame burners are used giving 12 candles' light per 5 feet of gas as above-mentioned, 2700 cubic feet of gas would be required, the total cost of which is 5s. 5½d.; or 1s. 1½d. more than the "Albo-carbonised" gas if the cost of the "Albo-carbon" is 6d. per lb., and 1s. 7½d. more if the "Albo-carbon" has cost 40s. per cwt.; or a saving of about 20 per cent in one case and 30 per cent in the other.

If the ordinary gas is used in argand burners of good construction, the comparison as regards cost is not so favourable to the "Albo-carbon" light. Such a burner will give a light equal to 18 candles per 5 feet of gas used. In order, therefore, to produce a light equal to 24 candles for 270 hours, 1780 cubic feet of gas would be required, and the cost of this is 3s. 7d., or 9d. less than the "Albo-carbonised" gas when the "Albo-carbon" has been bought at 6d. per lb., and one penny less if it has been bought at 40s. per cwt.

There are many objections to the use of argand burners, many of them on the score of their requiring more care and attention to keep them in good order; at any rate it is found in practice that flat-flame burners, consuming about 5 feet per hour, are chiefly used for general household purposes, and the comparison between the latter and the "Albo-carbon" light is therefore, for practical purposes, of more use in determining the relative value of the two modes of lighting.

The cost of an equal amount of light from the enriched gas is not only less than when ordinary gas is used in 5 feet flat-flame burners, but there is less vitiation of the air by the products of combustion. I find that in burning one cubic foot of enriched gas 0.70 of a cubic foot of carbonic acid gas is formed, whilst from the 2.70 cubic feet of gas alone, required to yield an equal amount of light, 1.51 cubic feet of carbonic acid is formed, or more than twice as much. Again, as regards sulphur, Newcastle gas usually contains about 0.01 grain per cubic foot. Naphthalen contains none. Seeing that nearly two-and-three-quarter times as much gas alone is required to produce an equal amount of light as when "Albo-carbon" is used, and that "Albo-carbon" contains no sulphur, there is nearly two-and-three-quarter times as much sulphur passing into the air of the room as sulphurous acid when the same amount of light is produced from gas alone as when "Albo-carbon" is used.

As regards the heat produced by the combustion in each case, I calculate that one cubic foot of the enriched gas will develop 745 British heat units, and that the 2.70 cubic feet of gas alone, required to produce the same amount of light, will develop 1809 heat units, or about two-and-a-half times as much heat.

In warm weather this additional heat is sometimes objectionable. In winter, however, the living rooms of our houses are made pleasantly warm by the heat arising from the burning gas. It is the carbonic and sulphurous acids with which the heat is accompanied which sometimes cause the air of such rooms to become unpleasant and oppressive. If these gases could be removed the heat would not be objectionable.

From what has been already stated it will be seen that the "Albo-carbon" light has many advantages over common gas alone. It must not be assumed, however, that it has no disadvantages. The following may be placed in this category:—

1. The lamp, at any rate as applied to ordinary brackets and chandeliers, is somewhat ugly in form, and throws an unpleasant shadow. The requirements of the case do not lend themselves readily to an artistic and elegant form. The larger lamps with six or eight burners, and with the naphthalen reservoirs below the burners, are the most elegant in form.

2. There is the labour and inconvenience of replenishing the spherical vessels with fresh "Albo-carbon" from time to time. The single-burner lamps are expected to burn for about 24 hours when fully charged with "Albo-carbon." The process of re-charging will probably have to be undertaken about twice per week. This I expect will be found

a troublesome and irksome process as compared with the readiness and convenience of ordinary gas.

3. In order to heat the apparatus and the "Albo-carbon," so that the vapour of the latter is formed in sufficient quantity to develop much light, the gas alone has to be burned for some time after it is first lighted, and as it is necessary to use a form of burner which is not suitable for developing light from common coal-gas, a very inferior light is produced during this process of heating. In my experiments the amount of light from the gas burning at the rate of 4.1 cubic feet per hour under a pressure of 1.2 inches was only equal to 2.4 candles when the gas was first lighted. In half an hour the light was considerably improved, but it was not until an hour had elapsed that the light became equal to 24 candles. This objection may be got over by lighting the gas half an hour or an hour before it is wanted, but this incurs additional expense and trouble.

4. Should the apparatus containing the naphthalen become overheated, more of the naphthalen is vapourised than can be properly consumed, and the flame gives off smoke accompanied with a disagreeable smell. When this occurs the amount of naphthalen vapour passing to the burner can certainly be regulated by turning a two-way tap in the lamp; but this requires care and attention, and much injury may be done to the furnishings and decorations of rooms should it be neglected.

There is no doubt that the "Albo-carbon" apparatus greatly enriches ordinary coal-gas and causes it to yield a beautiful white light at a cost less than the same amount of light can be obtained for from ordinary gas burnt alone in ordinary flat-flame burners. In the hands of careful people who choose to take the necessary trouble about it this form of light will be used with considerable advantage; but whether the extra care and attention it demands will, as in the case of the argand burner, prevent its being largely used in the place of the more convenient, although inferior, ordinary gas burnt in flat-flame burners; or whether both these modes of lighting will be ultimately superseded to a great extent by the more beautiful and purer light of the incandescent electric lamp of our President, or by some other form of electric lighting, time will reveal.

The thanks of the meeting were then given to Mr. Glover and Mr. Pattinson for their papers.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

January 23, 1882.

MR. ROBERT R. TATLOCK, President, in the Chair.

DR. JAMES R. M. ROBERTSON read a paper on "*The Occurrence of Opals in Central Australia and Queensland*," and showed a large number of very fine opal specimens. (See pp. 95 and 101)

An interesting discussion followed, in which Mr. Young, Dr. Dobbie, Mr. Glen, Mr. Kirsop, Mr. Mayer, and Mr. Whitelaw took part.

A hearty vote of thanks was then accorded Dr. Robertson.

Hydrodynamic Experiments, affording an Imitation of the Phenomena of Electro-magnetism and Induction by means of Liquid Currents.—C. Decharme.—The author remarks that M. Bjerknæs in his hydrodynamic experiments by means of bodies pulsating or vibrating in water, imitating the phenomena of static electricity and magnetism, has found everywhere an inverse analogy. M. Decharme in his experiments with liquid currents finds a direct analogy between hydrodynamic phenomena and those of electro-magnetism and induction.—*Comptes Rendus*.

OBITUARY.

PROFESSOR A. FREIRE MARRECO, M.A., F.C.S.

THE death of Professor A. Freire Marreco has created a conspicuous blank in the scientific world and in the higher circles of Newcastle society. The deceased gentleman was much and deservedly esteemed by all with whom he exchanged the courtesies of private life, and by whom his loss is mourned as that of a dear personal friend. His superior scientific attainments and extensive knowledge in the direction of literature and art, rendered him at home on most subjects, but the charm of his conversation lay in his refreshing originality and humour, and this, with his ready command of language, constituted him a conversationalist of the most brilliant order. As a teacher of chemistry he was no less popular. Lucid in his explanations, and conclusive in his reasonings, he presented to the youthful mind the dry bones of science in an attractive and intelligible form, and being himself an earnest and persistent student of almost the whole circle of the sciences, he was a worthy guide and example to the students under his charge. He was ever ready, at any personal inconvenience or cost, to help forward every movement calculated to disseminate science amongst the masses, and laboured with characteristic zeal to knit together North Country chemists in the bonds of fraternity. In virtue of this, he was one of the originators and promoters of the flourishing Chemical Society of Newcastle, to whose literature he was a valuable contributor, and in whose proceedings he ever interested himself warmly: it need scarcely be added that his death will be acutely felt by its members. His old students will lament the removal of one whom they almost revered, and certainly looked upon as the very embodiment of a profound chemist and successful teacher, and every admirer of rare ability and exceptional individual merit will regret the death of one who, just in the prime of life, has been taken from the profession which he adorned so much and loved so well.

NOTICES OF BOOKS.

Report on an Investigation of the Character and Chemical Constitution of the Fibre of the Flax Plant. By F. HODGES, F.C.S., &c.

THIS paper is a reprint from the *Proceedings of the Royal Irish Academy*, and is of no small importance as throwing light upon the fundamental principles of bleaching. The author points out that the experiments upon which Kolb's report is based (1868) were made exclusively upon yarn spun with Russian dew-retted flax. He has therefore found it necessary to repeat the experiments with Irish flax, and has made a special study of the wax and other bodies in addition to cellulose found in the stem of the flax-plant. He states that iodine and sulphuric acid render the bast-cells blue, whilst sulphate of aniline on the unbleached fibre shows the presence of some adhering and encrusting matter by the production of a yellow colour. In the perfectly purified and bleached fibre this reagent usually causes no change of colour, unless some of the encrusting matters have not been removed. The short cells and vessels situate on the inner side of the bast bundles of the plant are not rendered blue by the action of iodine and sulphuric acid.

In operating upon pure Irish milled flax of medium quality, the author found the loss of weight, after drying twelve hours, equal 9.7 per cent. His next step was the examination of the so-called wax, or gummy matter which is originally spread in a uniform manner over the surface of the fibre, but which after retting takes the form of bril-

liant scales, much of which, it is remarked, is removed from the fibre by the mechanical process of hackling. The substance in question has not been thoroughly examined. Berthelot viewed it as a yellow pigment; Kirwan as a resinoid, differing from the true resins by being insoluble in the essential oils. De Lisle considered it to partake of the nature of gummy extractive matter, whilst Grimshaw attributed the colour of raw flax to the presence of iron. The author, by treatment with ether, obtained a solution which gradually turned light green and finally darkened, and on cooling deposited a white substance in flocculent masses. On distilling off the ether from the solution whilst still hot, there was obtained a mass of a waxy matter and of essential oil,—the latter in too small quantities to admit of close examination. The wax appears to be of a complex nature, but the author has recognised in it cerotyllic acid.

On treating the flax which had been previously extracted with ether and alcohol, with caustic soda, a liquid was obtained which with excess of hydrochloric acid gave a precipitate—apparently metapetic acid. This precipitate was found insoluble in absolute alcohol and ether. The author here remarks that a substance obtained from jute by Messrs. Cross and Bevan, whilst working in a similar way, was soluble in alcohol, and therefore could not be a petic acid.

The author's experiments are far from being completed, and will, without doubt, lead to important results, both of a scientific and of a technical nature.

CORRESPONDENCE.

READING BURETTES.

To the Editor of the Chemical News.

SIR,—I recently invented a method by which the reading off of burettes may be accomplished in a very accurate manner, and think it may be of service to some of your readers. The only apparatus required is a small mirror, on the surface of which are pasted two strips of black paper, each, say, about 2" x $\frac{1}{4}$ " wide, with a space of about $\frac{1}{2}$ " between them. When reading off, the operator places the mirror behind and in contact with the burette, taking care that he can see the reflection of his eye in the space between the strips of paper, the top of the solution of course being also in the space.

In this latter precaution lies the efficacy of the method, as, no matter what the height of the solution, the eye of the operator must needs be at right angles to the burette when reading off the scale, and hence his readings will be always correct.—I am, &c.,

JAMES H. McMAHON.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 8, February 20, 1882.

Double Salts of Mercury.—M. Berthelot.—A thermochemical examination of mercurial iodides and chloroiodides.

Practical Solution of the Problem of the Transmission of Force to Great Distances.—Maurice Levy.—The author examines if it is possible to transmit a given quantity of energy to any distance whatever, obtaining a yield as close as possible to the required unity, under the

twofold conditions of not exceeding a given electromotive force and of employing merely machines commonly met with, such as those of Gramme and Siemens. He decides the question in the affirmative.

Compass without Resistance.—intended for Measuring intense Currents.—MM. Terquem and Damien.—This paper requires the accompanying diagram.

Saturation of Phosphoric Acid with Bases and on Chemical Neutrality.—A. Joly.—The author refers to the conclusion of MM. Berthelot and Louguine that phosphoric acid is not, strictly speaking, a tribasic acid in the same sense as, e.g., citric acid, and that it should be more properly regarded as a mono-basic acid with mixture function. He finds that the solutions of ordinary phosphates with a single equivalent of base, soda, potassa, or ammonia, which redden litmus strongly, are neutral to helianthine, like the corresponding nitrates. The first equivalent of alkali behaves therefore with ordinary phosphoric acid as it does with the monobasic acids properly so-called.

Hydro-ferrocyanic Acid.—M. Joannis.—The formation-heat of hydro-ferrocyanic acid, from the combination of its elements, is +93.6 cal.

Action of Iodine upon Naphthalene at High Temperatures.—A. Bleunard and G. Vran.—Iodine withdraws hydrogen from naphthalene forming hydriodic acid, and there is produced a new body, $(C_{10}H_6)x$, which represents naphthalene less two atoms of hydrogen.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. x., Part 10.

Knop's Method of Improving Soils as Applied in Denmark.—C. F. A. Tuxen.—It is remarked that soils with high absorptive power may be poor if such power depends on a high proportion of humic acid and humates.

Results of the Principal Manurial Experiments carried out by Lawes and Gilbert in England, and their Value for German Agriculture.—Dr. F. Behrend.—A summary of the results of the Rothamsted experiments.

Excretion of Urea.—H. Oppenheim and J. Mayer.—The former author has examined the daily distribution of the excretion of urea, the influence of great quantities of water, of coffee, of quinine, of perspiration, and of muscular work. Mayer concludes that the elimination of urea does not increase with the elimination of water.

Absorption in the Stomach.—H. Tappeiner.—The stomach has, in comparison with the bowel, little power of absorbing aqueous solutions, but absorbs readily dilute alcohol and bodies dissolved therein.

Digestion of Cellulose.—Dr. Hofmeister.—The mixed saliva of the horse is almost without action upon crude vegetable fibre.

Experiments on the Formation of Fat in the Animal Body.—Prof. F. Soxhlet.—The fat formed during the fattening of animals is produced mainly from carbohydrates.

Excretion of Gaseous Nitrogen from the Animal Body.—Prof. M. von Pettenkofer and C. von Voit.—In opposition to Seegen and Nowak, the authors maintain that no nitrogen is excreted save in the urine and dung.

Vol. x., Part 11.

Action of Different Phosphates on Dry and Moist Sandy Soils.—H. Schultz-Lupitz.—Steamed bone-dust gave the best results. Peruvian guano, both crude and dissolved, and patent manures, were dubiously remunerative.

Results of the Manurial Experiments of Lawes and Gilbert.—Dr. Paul Behrend.—Continued from the last number.

Archives Néerlandaises des Sciences Exactes et Naturelles.
Tome xvi., Livraison 3.

This issue contains no chemical matter.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome viii., December, 1881.

This number contains no chemical matter.

MISCELLANEOUS.

The Chemical Laboratory of Wiesbaden.—Besides the Director, Geh. Hofrath Prof. R. Fresenius, there are engaged as teachers in the establishment, Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Oberlehrer F. Henrich, and Architekt T. Brahm. The assistants in the laboratory in the Winter Term, 1881-2, were twelve in number, and in the Versuchsstation two. In the Winter Term, 1881-2, there were 56 students on the books. Of these, 39 were from Germany, 4 from England, 4 from North America, 3 from Austro-Hungary, 2 from Sweden, and 1 from France, Spain, Russia, and South America. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

Note on Aconite Poisoning.—A sparrow was poisoned with scrapings of aconite root, and died within an hour. On opening the viscera, nearly all the root (weighing perhaps one-tenth grain) was found in the gizzard, very little being left in the crop. The contents of crop and gizzard were mixed, evaporated to dryness under 60° with a drop of tartaric acid, the residue digested for some hours with alcohol in the cold, and the filtered extract evaporated (below 60°) to dryness and taken up with a few drops of water. Some bread crumbs soaked in one half of this solution and administered to a tom-tit, killed the bird within two to three hours. In the other half of the solution no aconitine could be detected either by the taste or chemically.—JOHN M. H. MUNRO, D.Sc., College of Agriculture, Downton.

MEETINGS FOR THE WEEK.

- SATURDAY, 11th.**—Physical, 3. "Experiments on the Formation of Fog," by Mr. Newth.
MONDAY, 13th.—London Institution, 5. "Animal Movements," by Mr. Maybridge.
— Medical, 8.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
— Society of Chemical Industry, 7.30. "Note on a New Source of Potash Alum," by Mr. J. Spiller.
— "The Manufacture of Alumina Sulphate," by Mr. B. E. R. Newlands.
TUESDAY, 14th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.
WEDNESDAY, 15th.—Society of Arts, 8. "Gas for Lighthouses," by John R. Wigham.
— Meteorological, 7.
THURSDAY, 16th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Chemical, 8. "On Valency," by Dr. Armstrong.
— "On Pentathionic Acid," by Watson Smith and T. Takamatsu. "On some Constituents of Resin Spirit," by G. H. Morris. "On the Preparation of Diethyl-naphthylamine, and the Action of Sulphuric Acid on that Substance," by B. Smith.
— London Institution, 7.
— Royal Institution, 3. "Resemblances of Sound, Light, and Heat," by Professor Tyndall.
FRIDAY, 17th.—Royal Institution, 9. "Infra-red Rays of the Spectrum," by Captain Abney.
SATURDAY, 18th.—Royal Institution, 3. "Volcanoes," by Prof. H. G. Seeley.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Arsenic in Commercial Muriatic Acid.—Will any of your readers kindly inform me whether a sure test for the presence of arsenic in commercial muriatic acid exists which can be readily applied by workmen?—E. H. MORTON.

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THE CHEMICAL

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ON THE
ATOMIC WEIGHT OF BERYLLIUM AS
DETERMINED BY ITS PHYSIOLOGICAL ACTION.

By JAMES BLAKE, M.D., F.R.C.S., Calistoga, California.

NOTWITHSTANDING the many experiments that have been made to determine the atomic weight of beryllium, its true position amongst the elements is still undecided, as is shown by the conflicting views of Nilson and Pettersson (*Berichte der Deutschen Chem. Gesells.*, vol. 14, p. 1451) on the one hand, and of L. Meyer (*Berichte*, 14, 1780), Brauner (*Berichte*, 14, 55), Carnelly, and Watts on the other. As the physical properties of the metal and its compounds have not so far furnished data to determine its true position amongst the elements, I think the evidence derived from the physiological action of its salts may be of use in deciding the question. In a paper read before the Royal Society in 1840, I first published the fact that the physiological action of inorganic substances when introduced directly into the blood of living animals, was determined by their isomorphous relations, all the substances in the same isomorphous group causing analogous physiological reactions. In 1870, in a paper read before the California Academy of Sciences, I showed that amongst the compounds of the more purely metallic elements in the same isomorphous group, the intensity of physiological action was determined by the atomic weight; the higher the atomic weight of an element in the different isomorphous groups, the smaller the quantity required to cause the same amount of physiological action. Applying these facts to the determination of the position of beryllium as a member of the magnesium or of the aluminium group of metals, we have to ascertain if its salts, when introduced directly into the blood of living animals, give rise to physiological reactions analogous to those that characterise the salts of the Mg group, or such as are produced by the introduction into the blood of the salts of alumina and ferric oxide. We then have to consider if the quantity required to produce these reactions is in proportion to the atomic weight of the substance, considered as a member of one or the other of these isomorphous groups. This is not the place to enter into any detail as to the physiological action of these substances. I will merely state that the effects that are produced by the introduction of the salts of Be into the blood are the same as those caused by the salts of alumina and ferric oxide, and are strikingly different from the physiological reactions that are caused by the salts of the magnesium group of metals. As regards the quantity required to produce these physiological reactions, this also agrees perfectly with its atomic weight as a member of the aluminium group. In the rabbit the quantity of MgSO_4 per kilo. required to produce death is about 0.97 grm., and if beryllium were a member of the same group it would take about 1.5 of the sulphate to cause death. As a member of the aluminium group the quantity would be much less, as alumina sulphate is fatal in the quantity of 0.007 Al_2O_3 per kilo., and ferric sulphate with 0.004 Fe_2O_3 per kilo. The intensity of physiological action of the salts of beryllium is in accordance with its atomic weight as a member of the aluminium group, as it requires 0.023 of the sulphate to cause death, or about one-seventieth part of what would be required did it belong to the magnesium group. The facts furnished by the physiological action of the salts of Be plainly point out its position as a member of the aluminium group of metals. They certainly

do not admit of being interpreted as favouring either view of its position as seems to be the case with the evidence derived from the physical data that have been used to determine the question, for whilst the specific heat of the metal, the molecular volume of its oxide and of its sulphate, the molecular heat of the oxide, the atomic heat of the combined oxygen, and its general chemical characters serve to convince Nilson and Pettersson that the atomic weight is 13.65 and its oxide Be_2O_3 , these same data serve Brauner and L. Meyer to conclude that the oxide is BeO , and the atomic weight 9.11. I shall not here attempt to weigh the evidence that has been adduced in favour of Be being a member of Mg group. The fact that a substance is required with an atomic weight of about 9 to fill a vacant place in the Mendelejeff series of elements, and that whether beryllium can fill this place is regarded, *als eine letzenspage des periodischen systems* (Brauner, *loc. cit.*, p. 54), has perhaps unconsciously influenced the judgment of the strenuous supporters of this law in weighing the evidence. It would be well to remember that in the use of these physical constants to determine the molecular structure of the elements, no hard and fast lines can be drawn which would justify the assertion that their application is absolute. Exceptions are met with to the laws of Dulong and Petit, and to the law of Avogadro, which, in the present state of chemical science, we cannot account for. Even as regards the physiological action of isomorphous substances, a striking exception is found in the salts of potash, as I have stated in a paper containing a short resumé of my experiments published in the *Berichte*, vol. 14, p. 394 (an abstract of this paper was published in the *CHEMICAL NEWS*, vol. xliii., p. 191). After performing some hundreds of experiments in ascertaining the physiological action of compounds of more than forty of the elements, I certainly consider that the evidence furnished by the physiological action of the salts of beryllium as decisive of its position as a member of the aluminium group of metals.

NOTE.—In an article published in No. 17 of the last volume of the *Comptes Rendus*, entitled "De la Toxicité Comparée de Différents Métaux," by M. Ch. Richet, experiments are related that had been performed by placing fish in water in which metallic salts had been dissolved, and noting the quantities of different salts required to produce death. After alluding to the chemical classification and the atomic weights of the substances employed, M. Richet states, "Il ressort ainsi de ces expériences qu'il n'y a pas de relation à établir entre la fonction chimique et la puissance toxique." The most elementary knowledge of physiology would suffice to show how worthless are such experiments in disproof of the facts I have brought forward, as substances introduced into the stomach or to the breathing organs do not afford any criterion for judging what would be their action when introduced directly into the blood. Were I writing in a physiological journal I should not think it necessary even to allude to such experiments, but as chemists, it would seem, are not all acquainted with the great difference there is in the physiological action of substances according as they are introduced directly into the blood or slowly absorbed through mucous membranes, I take this opportunity of calling attention to this important fact.

Certain Phosphates Neutral to Litmus.—MM. E. Filhol and Senderens.—If we add gradually and very carefully to a solution of pure phosphoric acid, a solution of pure caustic soda, there arrives a point when the liquid restores the vinous tint to tincture of litmus either reddened by an acid or turned blue by a trace of alkali. This neutral liquid can be crystallised in an exhausted receiver over sulphuric acid. The crystals thus obtained are neutral to litmus; they are oblique rhomboidal prisms, containing 3 eqvts. of crystalline water. They may be regarded as composed of 1 mol. of mono-sodic phosphate combined with 1 mol. of di-sodic phosphate.—*Comptes Rendus*.

ON THE APPLICATIONS OF TANNIN.

By M. JUSTE KÖEHLIN.

TANNIN and the tannates are at present the mordants best suited for the alkaloidal colours. This property was recognised soon after the appearance of these colours. In 1856 the violet of Perkin was fixed by tannin, or by astringent bodies which contained it. Tannin, in principle, was not merely no novelty, but was perhaps the most ancient drug used in dyeing, as it figured under the form of galls, sumach, quercitron, myrobalans, bablah, gambier, &c. These astringents may play various parts. By means of their tannin they render aluminous mordants less easily attacked by acid colouring matters, hence occasioning economy so much more appreciable as the water is more calcareous. In virtue of their tannin they blacken iron mordants, and by their colouring matters they may add to the general tone or serve independently of colouring matters. These astringents have also important applications in other industries: they serve for weighting silks, for tanning skins, for making inks, and as antiseptics.

If tannin serves as a mordant for alkaloidal colours, it is by reason of its property of forming insoluble compounds with these colours. This property exists also in the insoluble metallic tannates, and these bibasic salts have the advantage of not dissolving in an excess of the colour. These mixtures of tannin and of colour give in fact both soluble and insoluble compounds, lakes which dissolve in an excess of tannin. This property renders dyes without a metallic oxide very delicate. This condition disappears when the tannin is changed into an insoluble metallic compound by means of tartar emetic, or pyrolignite of iron, or neutral alum, or dilute stannic chloride, or subacetate of lead, or gelatine, or potassium chromate.

To prepare the most insoluble compounds, or lakes of tannin, with the following colours there are required:—

To 4 parts magenta (rosaniline hydrochlorate), 5 tannin, 2 soda crystals.

To 4 parts aniline-violet (penta-methylated rosaniline hydrochlorate), 5 parts tannin, 1 soda crystals.

The same proportion holds good for malachite green:—

For 4 parts methyl-green, 10 tannin, 4 soda crystals.

For 4 parts methylen-blue, 5 tannin, 4 tartar emetic.

Methylen-blue with five times its weight of tannin forms a soluble compound. Finally to precipitate the tannin are required, to 5 parts, 1 part tartar emetic, and 1 soda crystals.

These proportions, which form lakes or the most complete precipitation, are not equivalent quantities, nor are they suitable for mixing steam colours. It is common to take tannin double the weight of the colouring matter for magenta and aniline-violet, triple for the greens, and as much as fourfold for methylen-blue. Tannin colours contain, besides, tartaric acid and the quantity of sodium sulphite necessary for their reduction. Tartaric acids acts as a solvent, and prevents colours fixed with tannin from becoming saddened. Nevertheless, we meet with colours so charged with metallic chlorides that tartaric acid cannot be added to them except in very small quantity for fear of injuring the vegetable fibre. Sodium bisulphite increases solubility and brightness. This reduction requires, even in certain cases, the addition of zinc powder. When reduced in this manner methylen-blue may be mixed with alizarin colours without the assistance of tannin. Some of these colours gain in intensity if applied upon cloth prepared with sulpholeates or stannates. All gain in fastness by immersion in tartar emetic before washing. They can then bear soaping at a boil, but they do not become faster as against the light of the sun. The passage through tartar emetic is effected with a hot solution of 10 to 20 grms. per litre, and the time of passage is one minute. The final transformation of tannin steam colours into insoluble metallic tannate is quite as necessary for

preparations of pure tannin intended for dyeing as for these colours. In either case it completes the fixation, and prevents the diffusion of the tannin in the dye-baths.

Tannin, or the astringents containing it, may be condensed on vegetable fibre without the intervention of an intermediary or a mordant. The solutions of these substances may yield their tannin alternatively either to the solvent or to the fibre. These preferences, or restitutions, are effected according as the degree of concentration gives a preponderance to the fibre or to the liquid. Thus cotton, which would be tanned in an astringent bath of a certain concentration, loses some of its tannin in a water which contains less tannin, and is completely and rapidly untanned in flowing water. This loss in water which still contains tannin does not represent an equal division between the tannin and the water. We observe more resistance on the part of the fibre than on that of the solvent. Thus cotton impregnated with tannin at 50 grms. per litre, and which would be completely untanned in pure water, would preserve all its tannin in a solution of 5 grms. per litre: it continues taking up tannin in a solution of 20 grms. per litre, but begins to be impoverished in water containing less than 2 grms. The tannin which the fibre has withdrawn from the solvent may return to that liquid as soon as the necessary degree of concentration no longer exists. Similar alternations may be observed with picric acid, eosine, &c.

In dyeing cotton absorbs tannin slowly. The process cannot be accelerated by heat beyond 50° or 60°. Above this limit the solvent no longer yields tannin, and the fibre begins to give it up again. This is one of the reasons why preparations in pure tannin require to be dried in hot air, and why they become streaky on drying cylinders heated with steam.

There are two methods of tanning cotton, by dyeing or padding. In the latter case the solution must be ten times stronger. In either case it will be found advantageous to transform the tannin into an insoluble salt, after which washing is practicable, and the homogeneity of the dye-baths is preserved. Steaming or drying goods prepared with tannin does not fix them, and does not hinder them from being untanned by water. For dyeing, 1 gm. tannin per metre of cloth and per 2 litres of water for an hour will give a mordant which takes a decided grey in acetate of iron; 10 grms. give a very deep grey, and 20 grms. a black. These dyeings done in the cold are more intense than at 50° or 60°. 100 grms. of tannin per litre padded, dried and passed into tartar emetic at 20 grms., will give the deepest shades on dyeing in methylen-blue.

By dissolving methylen-blue in an excess of tannin, the latter being in greater proportion as the bath is more dilute, it is possible to dye directly a light blue.

To obtain a heavy blue saturate in tannin at 24 grms. per litre, dry, fix in acetate of iron at 14° B., neutralised with 25 grms. chalk per litre; wash, dye in methylen-blue, and soap. A passage in acid, or in acid and sulphite, will withdraw from this blue the black matter which darkens it.

With iron and astringents calico-printers have compounded colours ever since the rise of this industry. We may thus obtain black with 1 litre tragacanth mucilage, 1 litre pyrolignite of iron at 18° B., 125 grms. tartaric acid, and 250 grms. tannin. By diluting this colour we obtain greys rivaling the alizarine colours in fastness. These greys may be dyed with other colouring matters, and preserve their tone on cloth prepared with stannates. Gallic acid greys are purer than tannin greys, but they are wanting in solidity.

Since the acquisition of the aniline colours tissue-printers make frequent use of the process of dyeing which consists in turning the mordants into tannates. These mordants, after dunging, are dyed in tannin with the addition of gelatine. This mixture, which preserves the white of the parts not mordanted, is added in fractions as it is absorbed, to prevent the coagulation of a concentrated mixture of glue and astringent. After this preparation a soap-bath at 60° withdraws the tannin from the parts not mordanted,

and the goods may then be dyed in green, violet, blue, &c. This process allows of designs with white discharges applied upon the mordant.

Mordants may be mixed at once with tannin, steamed, dugged, and dyed, as:—

Gum water	1 litre
Tartaric acid	150 grms.
Tannin	250 "
Red liquor, 16° B. .. .	1 litre

One of the most ancient uses of tannin was fixing mordants, especially in turkey-reds, where the process was known as galling. Gallnuts were used at first mixed with alum; then came steepings in infusions of sumach, galls, &c., followed by a steeping in alum neutralised. A padding in tannin at 50 grms. per litre, followed by a second padding in alum at 50 grms. per litre, neutralised with 50 grms. soda crystals, gives an immediate mordant, equally suitable for alizarin-reds and for aniline colours. —*Moniteur Scientifique.*

FIXATION OF ALUMINA AS A DISCHARGE ON INDIGO-BLUE BY MEANS OF ALUMINIUM CHLORIDE.

By G. SAGET.

THE property of hydrated aluminium chloride to be decomposed into alumina and hydrochloric acid when dried may be used for obtaining a discharge on indigo-blue, whilst alumina is deposited where the chloride has been printed, and may serve as a mordant for various colours. On adding manganese peroxide to the aluminium chloride Scheele's reaction is obtained upon the tissue, the nascent chlorine destroying the colouring matter and producing whites. This reaction requires the presence of water and a temperature of 100°. The aluminium chloride must be perfectly neutral. To prepare it alumina is thrown down from aluminium sulphate by means of ammonia. It is collected upon a filter, washed, and dissolved in pure hot hydrochloric acid, taking care always to have an excess of alumina. The clear liquid is decanted and evaporated until a crystalline layer forms on the surface. The chloride is then of a syrupy consistence, and partially crystallises on cooling. When it is to be used the crystals must be thoroughly mixed with the supernatant liquid. As for the manganese peroxide it is preferable to use that formed by the action of chloride of soda upon a salt of manganese, washing, and drying at 100°. The commercial peroxide contains too much impurities. The product thus obtained is reduced to an impalpable powder. The following discharge is then printed upon a medium indigo blue:—

Manganese peroxide	80 grms.
Aluminium chloride	300 "
Calcined starch	200 "
Water	420 "

After printing the pieces are steamed without pressure for an hour and a half, letting the vapours escape. There is obtained thus a design which is of a pinkish white, and which is cleared by a passage through weak hot hydrochloric acid. If the alumina is intended to serve as the mordant for a colour the pieces are washed in hot water, then in cold water, and dyed. In this manner the author has obtained upon indigo-blues fine designs in alizarin-reds, fustic, or quercitron-yellow, cerulein-greens, &c. The discharge above given is intended for a medium blue: for a light or a dark shade it must be let down or strengthened in proportion.

A precaution to be taken when preparing this discharge is to add the aluminium chloride last, otherwise there are formed clots very difficult to get rid of. The peroxide and the calcined starch are first mixed, then the water is added, and when the paste is very smooth the aluminium chloride

is stirred in by degrees. This discharge keeps well for a long time in a cool place. Manganic oxide may be substituted for the peroxide, but to obtain the same quantity of chlorine a double proportion of aluminium chloride is preferable. Hence, from an industrial point of view, the peroxide is preferable.

Lead peroxide gives with aluminium chloride an analogous reaction. The author has sought to prepare a mixture such that after steaming and a passage through a chromate a yellow discharge would be obtained. Unfortunately, such discharges do not keep, and are completely useless after the lapse of a few hours. The contact of the copper rollers decomposes them at once, lead chloride and alumina are precipitated, and hinder the action of the doctors. The result is the same if red-lead is employed. —*Moniteur Scientifique.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING FEBRUARY 28TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

March 3rd, 1882.

SIR,—In this, our fourteenth monthly report, we lay before you the results of our analyses of the 161 samples of water collected by us during the month of February on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 161 samples, one was recorded as "turbid," one as "slightly turbid," and two as "very slightly turbid." The remaining 157 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from February 1st to February 28th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 23 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Chelsea Water Company, one was recorded as "turbid," one as "slightly turbid," and one as "very slightly turbid." The remaining 20 samples were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Grand Junction Company, the whole excepting one recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 23 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It is observable that the steady improvement in the colour of the waters, and in their freedom from organic matter, to which we called attention in our last report, has been continued during the present month. This year, more early than usual, the waters have ceased to manifest the features characteristic of the winter season.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ESTIMATION OF ALKALOIDS BY POTASSIUM MERCURIC IODIDE.

By ALBERT B. PRESCOTT.

IN 1862, Ferdinand F. Mayer, of New York, reported* the uses of a standard solution of mercuric iodide with excess of potassium iodide, in a method of volumetric determination of the chief natural alkaloids. The standard solution was a "decinormal," or, taking Hg at 200, a twentieth normal solution of ($\text{HgCl}_2 + 6\text{KI}$), and has been generally known as Mayer's solution, in use for qualitative as well as quantitative purposes. Mr. Mayer so far extended his investigation that, for twelve alkaloids, he stated the number of milligrams of alkaloid precipitated by a cubic centimetre of his standard solution. These volumetric factors coincided with molecular quantities, proposed by theory and approved by experiment. The stated quantity of each alkaloid represented its equivalent weight, or the half its equivalent weight, or the whole or the third of twice its equivalent weight. The general correctness of the factors declared by Mayer has obtained frequent confirmation, though, as will be specified further on, some of his numbers have been found to require adjustment, irrespective of molecular quantities, and the combining numbers of some of the alkaloids of his list have become unsettled. Moreover, it has been found that the proportion of alkaloid to iodo-mercurate is in many cases varied by conditions, so that limits of dilution, time, temperature, &c., need to be prescribed. As a working process there still lacks an indicator for the end of the reaction,—one recommended by Mr. Mayer being palpably fallacious. Another demand for more investigation of the subject lies in apparent discrepancies between the volumetric factors of precipitation and some gravimetric analyses of the precipitates. Upon several of these questions I have at various times obtained some work, reaching as yet few conclusive results, but which may serve even now, with a careful study, to put the subject and its deficiencies in a more tangible shape.

A few years before Mr. Mayer's report, Thomas B. Groves, of Weymouth, England, communicated an investigation "On some Compounds of Iodide and Bromide of Mercury with the Alkaloids."† Mr. Groves obtained his compounds by precipitation with "a solution of three equivalents of iodide or bromide of potassium, and one equivalent of chloride of mercury" [$\text{Hg} = 100$], that is, the constituents of the reagent afterward standardised for volumetric use by Mr. Mayer. Mr. Groves introduces the alkaloidal mercuric iodides, &c., as a class of compounds which he believes has not hitherto been noticed, but in fact the qualitative reaction of alkaloids with solution of iodide of mercury and potassium had been communicated

some time before. It is referred to in "Gmelin's Handbook," among the combinations of metallic iodides.* A. von Planta-Reichenau, in a good compilation on the reactions of alkaloids, presented as a dissertation at Heidelberg in 1846,† accords potassium mercuric iodide a prominent place among the general reagents for these bases. Mayer credits the first report of the use of potassium mercuric iodide as a qualitative reagent for alkaloids to F. L. Winckler, in 1830.

Mr. Groves made precipitates from solutions of "one equivalent of alkaloid," in salt and with some excess of mineral acid, and "three equivalents of iodide (or bromide) of potassium" with "one equivalent of chloride of mercury," and then made quantitative determinations of the mercury and the iodine of these precipitates. In these analyses, a dried and weighed portion of the [washed] precipitate was dissolved in boiling alcohol, and the solution treated with an excess of fresh ammonium sulphide, to precipitate the mercury as sulphide. The solution was kept hot, slightly acidulated with nitric acid, and the mercuric sulphide separated and weighed. The filtrate was warmed to expel all hydrogen sulphide, and treated with solution of silver nitrate, for the gravimetric determination of the iodine. The difference was estimated as alkaloid. Mr. Groves reported the precipitates as perfectly crystallisable, from hot water or hot alcohol, but did not take the crystalline form for analysis. He made analyses of the precipitates of morphine, strychnine, quinine, and cinchonine. In duplicate operations the results agreed with each other fairly, the variations of iodine percentage being from 0.17 to 0.82 per cent of the compound. The results are given in support of the general formula (translating Hg to 200), AlkHgI_3 . This would be generally referred to the rational form, AlkHIHgI_2 . However, the formula is not very well supported by the results. By computing the percentages of alkaloids for Mr. Groves's formulæ we obtain:—

	Calculated.	Found.
Morphine in $\text{C}_{17}\text{H}_{19}\text{NO}_3\text{HgI}_3$.	39.91	35.99
	mean, from	35.97 and 36.02
Strychnine in $\text{C}_{21}\text{H}_{23}\text{N}_2\text{O}_2\text{HgI}_3$.	36.50	33.03
	mean, from	33.20 and 32.87
Quinine in $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_2\text{HgI}_3$.	35.80	30.14
	mean, from	30.40 and 29.88
Cinchonine in $\text{C}_{20}\text{H}_{24}\text{N}_2\text{OHgI}_3$.	34.64	29.08
	mean, from	28.56 and 29.60

Mr. Groves remarks that the obtained percentages of quinine and cinchonine correspond to molecular weights one-fourth less than those received.

A few months ago I obtained some determinations, by Messrs. Frank E. Judson and Charles E. Payne, of the percentages of iodine and mercury, in the iodo-mercurates of several alkaloids, namely, strychnine, morphine, quinine, and berberine. The analyses were done a little differently from those by Mr. Groves. The alkaloid precipitate was dried at 100° C., and a weighed portion dissolved in hot alcohol. It was found that the strychnine precipitate could be dissolved by acidulating the hot alcohol with sulphuric acid. Nitrate of silver solution was then added to precipitate the iodine, and the precipitate washed on the filter with hot water (dissolving out any silver sulphate precipitated by the alcohol), dried at 100° C., and weighed. The filtrate was treated with hydrochloric acid (in but slight excess), and the silver chloride filtered out, when this filtrate was charged with washed hydrogen sulphide gas, and the resulting mercury sulphide washed, dried at 100° C., and weighed. Having the iodine and the mercury, the fraction of hydrogen for the HI of the assumed formula was added, and the difference placed as alkaloid. Triplicate operations were made. The analysis of the strychnine precipitate gave the following results, placed parallel with centesimals calculated from a molecular formula, and with the mean of Groves's percentages

* *Pro. Am. Phar. Asso.*, 1862, 238; and again, more fully *CHEMICAL NEWS*, vii., 159, and on opium alkaloids, *Ibid.*, viii., 177, 189. *Am. Jour. Phar.*, 35, 20. *Zeitschr. An. Chemie*, 2, 225 (1863). *Jahresberichte der Chemie*, 1863, 703.

† *Quar. Jour. Chem. Soc.*, 11, 97, 188 (1859). *Phar. Jour. Trans.*, 18, 181. *Jahresbericht der Chemie*, 1858, 363. *Am. Jour. Pharm.*, 36, 333.

* "Cavendish Edition," 2 (1849), 184.

† "Das Verhalten der wichtigsten Alkaloide gegen Reagentien," &c.

	Calculated from $C_{21}H_{22}N_2O_2 \cdot HIHgI_2$.	1st.	Judson and Payne. 2nd.	3rd.	Mean.	Groves. Mean.
Iodine	381	41'59	40'69	40'00	40'46	44'19
Mercury.. .. .	200	21'83	19'60	21'20	19'77	22'78
H of HI.. .. .	1	0'11	—	—	0'11	—
Strychnine	334	36'47	—	—	39'66	33'03
	916	100'00			100'00	100'00

These results, in absence of direct determinations of the alkaloid, raise the question whether the iodo-mercurate of strychnine, as a precipitate, may not be in some degree complex and variable. This precipitate is one of the least soluble of the iodo-mercurates, according to Mayer, being obtained in a solution containing 1.127 gm. of strychnine. The end of the reaction is distinct, and the precipitate settles fairly in acidulated water, but better in concentrated solution of potassium chloride.* In this solution Dragendorff found each c.c. to dissolve 0.00216 gm. of the precipitate. Without potassium chloride, 0.1127 gm. of strychnine lost 0.0021 gm. in precipitating, washing, and estimating from the formula above assumed.† From these gravimetric experiments it appears that the precipitate in question must consist mainly, and may consist wholly, of double iodide of the formula $C_{21}H_{22}N_2O_2 \cdot HIHgI_2$.

The volumetric factor of 0.0167 gm. strychnine (containing 1.127 gm. of $HgI_2 + 4KI$ in grms.), is well established. I have several times obtained its verification with pure crystallised alkaloid. Dragendorff quotes experiments confirming the ratio.‡ Now our understanding of the chemical equation, in the formation of these alkaloid iodo-mercurates, must depend upon the composition of the precipitate, as we have little knowledge of the chemical composition of potassium mercuric iodide solutions. As a proposition we may take this equation—



This presupposes the following formation of Mayer's solution:—



The conditions of mixture of Mayer's solution seem to deny that it holds three molecules of free potassium iodide (as we have to specify further on). Nevertheless, some experiments in support of the above equations may be cited. A certain quantity (varied by temperature) of mercuric chloride may be added to Mayer's solution before a permanent red precipitate is attained. If, now, the solution just saturated with mercuric chloride, and containing the least perceptible precipitate of mercuric iodide, be treated with strychnine acidulated solution nearly to completion of the precipitate, and this be filtered out, the filtrate will not bear least addition of mercuric chloride without production of a red precipitate of iodide of mercury. That is say, all the iodide which is necessary to hold the mercuric iodide in solution enters into the precipitate of alkaloid mercuric iodide. The indication is that none of the iodide belonging to the potassium mercuric iodide and essential to its solubility becomes liberated in the precipitation with strychnine salt. These results are not peculiar to strychnine precipitation, as I obtained the same results with quinine, atropine, and aconitine. Another test, implying that soluble iodide is not liberated in the alkaloid iodo-mercurate precipitation, was made as follows:—Mayer's solution was saturated with mercuric chloride (to the point of precipitation), and then treated with excess of

quinine (and other alkaloid) acidulate solution, and filtered, when the filtrate would not precipitate mercuric chloride on its addition in any proportions.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

INSTITUTE OF CHEMISTRY.

At the Annual General Meeting of the Institute, which took place last month, the report of the Council was again most satisfactory.

The term during which the Council had the power of admitting members of the chemical profession to the Institute as Fellows without previously passing through the preliminary grade of Associate having expired, the qualifications required of Candidates for the Associateship have been carefully re-considered, especially with reference to the three years training demanded by the articles, and the examinations to be passed in physics, mathematics, and theoretical and practical chemistry.

During the session a conference has been held "On Certain Points in the Ethics of Professional Chemistry," the subject being introduced by Dr. Frankland, and it has also been determined to give a series of experimental demonstrations, illustrative of modern methods of analysis and of physical operations more immediately connected with chemical science; the first of these lectures, "On Modern Methods of Gas Analysis and the Apparatus employed therein," having been already delivered by Mr. Robert Warington.

The Council has also given the most careful consideration to the question as to whether it might not be of service to the members, and conducive to the welfare of the society, to publish a journal, which should be sent periodically to the members; but as at the lowest estimate a really useful and comprehensive journal would absorb the entire available revenue of the society, the Council considers that it would be unwise to do so, especially considering how important it is for an institution of this character to accumulate funds. Moreover, the Society of Chemical Industry have now begun the publication of a journal, and it is a matter for the new Council to consider whether it might not be of use to the members of the Institute to make arrangements for its gratuitous supply to them. It would appear that some of the Fellows have entertained the expectation that the Institute should in some such way return to them a substantial equivalent for the annual subscription—as the Chemical Society does—but it must be remembered that the primary object for which the Institute was founded is to ensure that those who act as consulting and analytical chemists are qualified by study and training for the proper discharge of the duties they undertake. It is obvious, therefore, that the true functions of the Institute are the establishment of the most efficient examinations in London and the Province, the public promulgation in every available way of the science of the Institute, and of the position accorded to the profession, and the accumulation of such results will allow of all possible steps being taken to promote public recognition, and as will, in course of time, enable the Institute to secure the permanent and elevated position, which should be its right as the representative

* Dragendorff, "Werthbestimmung starkwirkender Drogen" (1874), 62, 69.

† *Ibid.*, p. 63. Strychnine 0.1127 gm., with 7.5 c.c. of Mayer's solution (an excess of 0.8 c.c.), gave a precipitate of 0.3033 gm. Then $0.3033 \times 36.47 = 0.1106$ strychnine obtained.

‡ *Loc. cit.*, p. 62. Strychnine 0.0628 gm., in 10 c.c. solution, with 5 c.c. concentrated potassium chloride solution, required 375 c.c. Mayer's solution indicating 0.0626 strychnine.

the interests of the chemical profession, in the same way that the Colleges of Surgeons and Physicians represent the medical profession.

The guarantee which the Institute now furnishes will in each exceeding year of its existence increase in importance, and the status given by the Fellowship and Associateship become more fully recognised. Each successive year of its existence will see the objects of the promoters more firmly established and more fully developed, and, in due course, this Association, working steadily, though slowly, for the advancement of the welfare, the dignity, and public recognition of the profession, must, if loyally supported, take its place as one of the most important incorporated professional institutions of the United Kingdom.

PHYSICAL SOCIETY.

Saturday, March 11th, 1882.

Professor FULLER, Vice-President, in the Chair.

New Member:—Mr. D. Reece Jones.

Mr. NEWTH showed some experiments illustrative of the fact announced by M. Mascart in 1875 that solid particles in the air are necessary to the formation of fogs; and, secondly, that certain gases, such as sulphurous acid gas, also cause fogs in the same way by permitting the moisture to condense upon their particles. The experiments consisted in passing an electric light beam through large bulbs of glass containing air and a small quantity of water. When the air in the bulbs was washed with the water, and thus freed from moles, the fog produced in the bulb by slightly exhausting it with an air-pump was much less than when the air of the room, or smoke, or sulphurous acid gas was admitted into the bulb. The dust on a platinum wire, rendered incandescent within the globe by an electric current, also caused a sensible fog. It follows that with gas fires instead of coal there would still be fogs, though not so black ones.

Prof. F. GUTHRIE, F.R.S., read a paper "*On the Discharge of Electricity by Heat.*" This was concerned with additional experiments to those made by the author on the subject nine years ago. He showed by means of a gold leaf electroscope that a red-hot iron ball when highly heated would neither discharge the positive prime conductor of a glass electrical machine nor the negative one; but on cooling the ball a temperature was found at which the ball discharged the negative conductor, but not the positive one. Lastly, on cooling the ball still further (but not below a glowing temperature), it was found to discharge both positive and negative electricity. A platinum wire rendered red-hot by an electric current also discharged a negatively charged electroscope more readily than a positively charged one. When placed between two electroscopes, one having a + and the other a - charge, it discharged neither. When the + one was withdrawn the - was discharged; but when the - was withdrawn the + was not discharged. There therefore seemed a tendency in a hot body to throw out + rather more than - electricity. That a material medium between the heated body and the electrified one was necessary was shown by the failure of the experiment with a Maxim incandescent lamp consisting of a carbon filament in a vacuum bulb. Dr. Guthrie also showed the demagnetisation of a small magnet in the heat of a Bunsen flame by inserting it in a coil of wire connected to a mirror galvanometer, and heating it in the flame. He also showed that the pole of a voltaic battery could be discharged by heating it red-hot. This was done by connecting a piece of fine platinum wire to one pole and heating it in the flame of a spirit-lamp, care being taken to insulate the lamp to prevent conduction to earth. The discharge was shown by means of a mirror electrometer.

THE METEOROLOGICAL SOCIETY.

DURING last year the Council of the Meteorological Society, having regard to the rapid progress of late years in statistical meteorology, and the uncertainty that still prevails regarding important questions relating the physics of the atmosphere, considered it desirable that the Society should supplement the ordinary observations by a series of well conducted experiments destined to throw light on such questions as the vertical decrement of temperature, the rate of ascension of vapour, the height of cloud strata, the variation in the velocity of the wind at different elevations, &c. Steps have been taken during the past week to make observations on the first of the questions by the placing of thermometers at the summit and base of Boston Church Tower, which is 270 feet high. This tower is admirably situated for making such experiments, as it is isolated and free from any obstructions, and the ground is quite flat for miles round. By permission of the vicar, Canon Blenkin, the instruments have been placed as follows:—At the summit, one of Dr. Siemens's electrical thermometers (kindly placed at the Society's disposal by Messrs. Siemens, Bros., and Co.), and an ordinary thermometer, are mounted in a small screen fixed to one of the pinnacles of the tower; on the roof of the belfry, which is 170 feet above the ground, a Stevenson screen has been mounted containing maximum, minimum, dry, and wet bulb thermometers. In the church yard another Stevenson screen has been fixed containing a similar set of thermometers for comparison with those above. All the thermometers will be read every morning at 9 o'clock. The electrical thermometer consists of a coil of wire wound round a cylindrical piece of wood enclosed in a small brass tube; a third wire is joined to one of the wires, and the two, insulated by gutta-percha, form a light cable, which is brought down to the base of the tower and connected to a galvanometer, the terminals of which are in connection with the two poles of a six-cell Leclanché galvanic battery. The instrument is read by depressing a key which causes the needle of the galvanometer to deflect. A pointer or vernier (moving a contact roller upon a wire in a circular groove) is then pushed to the right or to the left upon a divided scale until the needle remains stationary on the zero-point, when the electrical resistance of the wire is measured upon the scale. The number indicated by the vernier is then read off, and by referring to a table of equivalents, the actual temperature in degrees of Fahrenheit is readily ascertained.

Simultaneous readings of the electrical thermometer at the summit of the tower, and of the dry bulb thermometer in the church-yard, will be made frequently during the day by the verger of the church.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, February 7, 1882.

R. ANGUS SMITH, Ph.D., F.R.S., &c., in the Chair.

"*The Colour Sense and Colour Names,*" by WILLIAM E. A. AXON, M.R.S.L.

"*Notes on Lead Pipes and Lead Contamination,*" by WILLIAM THOMSON, F.R.S.E.

The question of the contamination of water by lead pipes having been recently revived by Dr. Sedgwick Saunders's translation of M. Belgrand's brochure, made in accordance with the instructions of the Commissioners of Sewers of the City of London, I propose to bring before the Society a few notes on the same subject which may be of interest.

About three years ago I examined a sample of water to ascertain whether it contained any objectionable ingredients, and found it to be contaminated with lead to the

extent of 0.197 grain per gallon. The composition of this water was as follows:—

	Grains per Gallon.
Total solid matter	7.971
Organic matter, combined water, &c. ..	1.817
Saline matter	6.154
The saline matter was composed of:—	
Chlorides of sodium and magnesium ..	1.543
Sulphates of soda and magnesia ..	1.146
Sulphate of lime	2.328
Carbonates of lime and magnesia and oxide of iron	1.137
	6.154
Free ammonia	0.0028
Albumenoid ammonia	0.0035
Oxygen contained in potassium permanganate required to oxidise organic matters, &c., acting in the cold during three hours	0.028
Nitrates and nitrites	absent
Total hardness	3.8°

I advised that this water should not be used for drinking purposes on account of the lead which it contained, and I afterwards learned that one of the members of the family, being ill and under medical treatment, suspected that there might be something wrong with the water in question, because she was better in health when away from her home, and it was only after lead had been detected in the water that lead poisoning was even suspected by the medical attendant, and it then became evident that the patient was suffering severely from lead poisoning, all the symptoms being strongly marked. The gums were tinged of a bluish shade and the fingers of both hands had become stiff and partially paralysed.

The interesting points connected with this case are that whilst a number of persons were using this water only one suffered severely from lead poisoning, although others of the family were in indifferent health previous to, and enjoyed good health after, the removal of the lead pipe which conveyed the water from the well to the house. As this lead pipe, which was in all probability the cause of all the unhealthiness of the family, had been in use for twenty-one years, it would have been interesting to have known the condition of health of the previous occupants of the same house, and if not satisfactory, to have learned whether or no any medical man diagnosed any of the cases as those of lead poisoning, as there seems little doubt that those who lived in this house must have suffered, more or less, from this cause. It seems, unfortunately, probable that many persons may be suffering from slow lead poisoning without the real nature of the malady being recognised by medical men, as it was in the case of the lady above mentioned, who by philosophical reasoning and experiment solved the problem which puzzled the doctor.

The house referred to was supplied from a well about 500 yards distant, the water passing by gravitation through a 1-inch lead pipe, and although this pipe had been in use for twenty-one years, and the water which passed through it contained certain proportions of sulphate and carbonate of lime, yet the pipe had not become coated as M. Belgrand says is the case with the lead pipe in Paris, and as is generally supposed to be the case, but was, according to the description of the owner of the house, as free from inside coating when taken out as it was when put in.

I was asked to suggest a substitute for the lead pipe, and advised the use of tin-lined lead pipe where the coating was about 1-16th to 1-20th of an inch thick, because some samples which I had obtained and examined several years before did not in the slightest degree contaminate water when kept in the pipe for many days. My suggestions

were carried out, and a sample of the water which had passed through this tin-lined pipe sent to me for examination. I found it to be contaminated with lead to a considerable extent, and on examining some of the tin lining I found it to contain a large proportion of lead. I sent to another manufacturer of this tin-lined pipe for a sample. This he sent me, and again I found that the tin lining contained a large proportion of lead, and quickly contaminated water left in contact with it. This I communicated to the manufacturer, who informed me that he could not understand how the tin lining had become contaminated, unless it was by its being poured down the side of a strip of lead into the hole left in the solidified lead in the cylinder previous to forcing it through the dies by hydraulic pressure. As I understand, this pipe is produced by pouring melted lead into a cylinder, through the top of which an iron shape is introduced to make a cavity in the lead of sufficient size to hold the necessary quantity of tin; the lead is then allowed to set; when this occurs the iron shape is withdrawn and molten tin poured in to fill the space which the iron shape previously occupied; a "die" composed of an iron tube with a core dips into the tin, which remains liquid in the cavity, whilst this outer tube forms the core of another tube through which lead is forced, the innermost core being prolonged, so that the tin comes in contact with and solidifies on the interior of the lead pipe. It seemed to me remarkable that a manufacturer who was cognisant of the fact that tin dissolved lead should have allowed such a device as the pouring of the tin down a strip of lead to be employed for filling the mould.

These tin-lined lead pipes, I understand, are used to a large extent, and principally in making communication between the beer in the cask and the pump on the counters of beer retailers. Such pipes would give the idea of safety, but it is clear that many samples of it may be of such a nature as to contaminate beer with lead to a large extent, as the beer contains a certain amount of free acid which would in all probability be capable of dissolving the lead; and one would expect that the person who consumes the first glass of beer from the pump in the morning would get that which had remained over night in the pipe, and would imbibe, therefore, a considerable quantity, depending on the quality of tin lining, of the poisonous metal.

To test whether this was really the case, a few days ago I got two samples of beer, drawn in the morning, from two pumps at the same place, and examined them, and found a considerable proportion of lead to be present in each. To find whether it was possible to obtain tin-lined lead pipe, in which the tin was free from lead, for making communication between the house and well above mentioned, I obtained a number of samples of this variety of pipe from the same and from different manufacturers, and tested the purity of the tin lining inside each, but failed to find one which was not contaminated with lead, and which did not contaminate water when left in contact with it for two or three days to a greater or lesser extent; one or two samples, however, contained very little lead, and only caused a minute trace of contamination in the water, but the majority contained a large percentage of lead, and polluted the water to a great extent. Ultimately, the gentleman who occupied the house referred to had the tin-lined lead pipe which replaced the lead one dug up, and communication with the well established by 500 yards of block-tin pipe; and since this change was made, he informed me lately that his family have enjoyed good health.

There is another kind of lead pipe manufactured called "tinned lead pipe," the inside of which is covered with a very thin coating of a white metal to afford protection against the action of water on lead—as a matter of fact, this coating is not tin at all. It is produced by filling the first few inches of the ordinary lead pipe which is forced through the dies, whilst still very hot, with molten tin, which remains molten and washes the inner surface of the lead tube as it is produced. Presumably, when a long

length of pipe has been forced through the dies, there would be little or no tin remaining, but I was informed by a manufacturer of this pipe that that is not the case; on the contrary, there is a much larger volume of tin, to use his own language, at the end of the operation than there was at the beginning; the molten tin dissolves the lead, thus increasing in volume, and so the coating is a mixture of lead and tin, the proportion of lead in the coating being greater in those portions of the pipe which are last forced through the die.

Some years ago, not knowing of the existence of this kind of tinned lead pipe, I requested a plumber to make for me a worm refrigerator with tin-lined lead pipe for the preparation of distilled water. He did so, and to my astonishment, on testing the distilled water which had been condensed in it, I found it to contain a large proportion of lead. On examination of the pipe afterwards I found it to be the variety which had been washed with tin. This coating cannot therefore be regarded as a thoroughly efficient protection against the action of water on lead, but the test was a severe one, and there can be no doubt that tin-coated lead pipe is much better adapted for use in making communication with the water mains in large towns than the ordinary lead pipe, whilst the cost of producing this coating, I understand, amounts to only a few shillings per ton of pipe. To test their respective values I placed water containing a small proportion of nitrate of ammonia in two pipes of the same sizes, the one tinned inside, the other the ordinary lead pipe. After standing about three hours I tested the water from each; the one from the tinned lead pipe contained only a trace of lead, whilst that from the ordinary lead pipe contained a large proportion of lead in solution. Similar results were obtained by leaving Manchester water in the same pipes for eighteen hours.

In certain boroughs, I understand, such as Salford, Oldham, and Southport, this tinned lead pipe is the only kind allowed to be used for making communication with the main, whilst in Manchester and other places ordinary lead pipe is generally employed. I have lately observed that the lead pipes which have been in use in Manchester for many years contaminate water left in them over the night to a considerable extent, but after the water has been used for a short time during the day it is free from any appreciable trace of lead.

I have also tested the water after remaining eighteen hours in the lead pipes in communication with the main in Salford where the tinned pipes are employed, and although the water was slightly contaminated with lead, it contained much less than that found in the water which stood for the same length of time in the ordinary lead pipes of Manchester.

It is a fact, which I have observed from my experience during the last few years, that aerated waters are contaminated with lead much more often, and in many cases to a much greater extent, than one would expect, considering the attention and care which is bestowed by good firms on the manufacture of these articles. Lately I tested several samples of what was termed "pure" carbonate of potash, and "pure" carbonate of soda, and citric acid, which were specially purified for use in the preparation of aerated waters, and I found all to be contaminated with lead to a greater or less extent. The manufacturer of these samples was apprised of this fact, and in reply he admitted that they contained traces of lead, but said it was impossible to obtain these substances free from metallic contamination at anything like reasonable cost, and he was quite satisfied that the quantity was not objectionably large. To overcome this difficulty I had to advise the use of the ordinary carbonate of soda, made by Solvay's ammonia process, as being almost as pure, and certainly much less likely to be injurious, than the purified salt. I also advised that those salts which it is impossible to obtain free from lead should be dissolved in water, and filtered through or boiled with animal charcoal, which has the property of removing the lead from solution. It

might here be noted that the use of charcoal filters diminishes very much the risk of lead poisoning, as the charcoal removes any trace of lead which the water might contain.

It was first discovered and afterwards published by the late Dr. Crace-Calvert and Mr. Richard Johnson in a joint paper, that pure lead is more easily acted on by sulphuric acid than lead containing a very small percentage of impurities such as antimony and copper, and these results have been repeatedly verified since. With a view to find the effect of pure water on comparatively pure lead and on lead to which I added $\frac{1}{2}$ of a per cent of antimony, I melted some of the original lead and poured some out, which I rolled into a sheet. Antimony was added to the remainder, and the mixture poured out and rolled into a sheet as before: both sheets were cut to the same size and placed in equal bulks of distilled water and left overnight. In each case a fine white flocculent crystalline matter, an oxide or salt of lead, was observed in suspension, but this existed in considerably greater proportions in the water containing the lead which had not been treated with antimony. Thus the small quantity of antimony appears to afford some protection against oxidation of the lead by air and water. When the suspended matter was filtered off only a trace of the lead was found to be in solution in each case.

It is sometimes advisable to obtain the lead contained in water in a contracted solution, and preferably in an acetic acid solution if possible. I have observed frequently that weak acetic acid dissolves no lead from the residue left on evaporating waters which gave originally a very distinct colouration with sulphuretted hydrogen, but on treating the residue with strong nitric acid, evaporating off the acid completely and again treating the residue with weak acetic acid, the lead dissolves with apparent facility, and on evaporating this acetic solution of the metal to a drop or two, it may be obtained in a sufficiently concentrated solution for the application of the other tests. It appears as if certain organic matters contained in the water combine with and render the lead insoluble in acetic acid; these organic substances being afterwards decomposed by the nitric acid, leave the lead in a condition in which it is soluble in acetic.

A curious case of lead poisoning lately came under my notice and engaged the attention of a Lancashire coroner. A woman, upon whose body the inquest was held, had been employed in weaving cloth from yarn, which had been dyed of a yellow colour. The colour was the ordinary chromate of lead, and it was alleged that the dye had caused her death by poisoning.

I examined some of this yarn, which I found to be of an orange-yellow colour due to the chromate of lead which had been fixed in the fibre, but it was so loosely fixed that by gently shaking a hank the chromate came out, forming a cloud of yellow dust, and it was given in evidence at the coroner's court that all or nearly all the workpeople who had been engaged in weaving this cloth suffered more or less from lead poisoning.

I afterwards examined some yarns containing the same pigment colour fixed in the thread so firmly that it could not be removed by shaking.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 9, February 27, 1882.

Induced Currents of Polar Interversions.—Th. du Moncel.—The author finds that the three effects of which he has spoken (*Comptes Rendus*, 1872, p. 1335, and 1879,

p. 353) are certainly operative in the Gramme machine, and that the currents of polar intervention are distinct from those resulting from the movement of a coil in a magnetic field fixed according to the axis of the magnetic ring.

Double Salts of Mercury.—M. Berthelot.—A series of thermo-chemical determinations.

Colouring-Matter forming in Starch Paste.—Lecoq de Boisbaudran.—The author laid before the Academy a specimen of a fine violet colour developed about fifteen years ago by the action of a small organism occasionally found on the surface of starch paste preserved for some time in moist air, and especially if exposed to the vapours of acetic acid.

Moniteur Scientifique, Quesneville.
December, 1881.

The Products of the Caoutchouc and Gutta-percha Industries at the Exhibition of 1878.—This paper as well as those succeeding, on glues, gelatines, inks, blacking, and starch, are not susceptible of useful abstraction, and their interest is chiefly historical.

Studies on Quinamine.—O. Hesse.—A translation from *Liebig's Annalen*.

New Salts of Platinum.—O. Hesse.—From *Liebig's Annalen*.

On Conquinamine.—O. Hesse.—Conquinamine and quinamine are two isomeric bases which undergo modifications with equal ease and in the same direction, but which are not capable of mutual conversion.

A New Derivative of Quinine.—E. H. Rennie.—From the *Journal of the Chemical Society*.

On a New Alkaloid found in the Chinchonas.—M. Arnaud.—From the *Comptes Rendus*.

Gum Kauri in New Zealand.—From the *Journal of Applied Science*.

Coating Metals with Nickel.—A. Gaiffe.—The author describes the appliances required and the successive processes which the articles undergo, rather from the point of view of an amateur than of a manufacturer.

Industrial Society of Geneva.—Meeting of October 12th, 1881.—M. Stamm reported upon a communication by M. Degermann on black dyeing with logwood and iron and tin mordants, and on the black spots which sometimes appear on woollens dyed a cochineal-scarlet.

Proceedings of the Chemical Society of Geneva.—January 16th, 1881.—M. Kaspar gave an account of a specimen of insoluble albumen prepared from serum, at the Geneva Abattoir. It contained a proportion of sulphur three times greater than that of normal alcohol.

M. A. Danilewsky described his researches on myosine, its preparation, its transformation into syntonine, and its regeneration.

February 13th, 1881.—Prof. Monnier described a new method of determining nitric acid in spring- and well-waters.

Prof. Graebe described the researches of M. Mann on a novel homologue of desoxyberzoïn, and of M. Herold on certain derivatives of ortho-anisidine.

March 12th, 1881.—Prof. Graebe exhibited certain apparatus for the volumetric determination of nitrogen, and for the electrolytic determination of copper in solutions where it is contained along with other metals. He made also some observations on the preparation of phosphorus trichloride.

Prof. Monnier exhibited a pocket apparatus for the rapid determination of urea and urine.

April 10th, 1881.—Prof. Graebe described the researches of M. Wolf on the production of anthragallol from anthracen.

M. Lossie gave an account of the electro-separation of metals as successfully employed at La Coulouvrenière.

May 8th, 1881.—Prof. Graebe described certain researches executed by M. Lauterbach on the sulpho-conjugated acid of dinitro-naphthol, the potassium salt of which is known as "naphthaline yellow S." He made also some observations on the impurity of the benzoic acid of commerce, which may contain as much as 35 per cent of para-chloro-benzoic acid.

June 26th, 1881.—M. Aimé Pictet has prepared certain derivatives of dextro-tartaric acid, and studied them optically.

Prof. Graebe finds carbazol dissolved in sulphuric acid an exceedingly sensitive reagent for nitric acid. It produces a green colour.

Prof. Monnier proposes a new method for the analysis of milk. He pours into the sample a solution of copper sulphate, which precipitates all the caseine as copper caseate, carrying down with it the fatty matter. These two substances are separated by means of alcohol and ether. There remains in solution the milk-albumen, or lacto-proteine, which is also thrown down as a salt of copper on raising the liquid to a boil. (The sugar?) These solutions filter with great difficulty.

On Galleine and Cœruleine.—M. C. Buchka.—From *Liebig's Annalen*.

Improvement in the Manufacture of Crude Soda.—M. Louis Faucheaux.—The author patents an improvement in black-ash furnaces.

Adulteration of the Essential Oils.—From the *Journal of Applied Science*.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 3, November and December, 1881.

This number contains no chemical matter.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 15, 1881.

The Electric Battery at the Exhibition.—C. Maze.—A popular account of the nature and action of the battery in its different forms.

Modern Chemical Doctrines.—M. Gerber.—A lengthy summary, incapable of useful abstraction.

The Conveyance of Electricity.—A. Hamon.—This paper cannot be reproduced without the accompanying illustrations.

No. 16, December 22, 1881.

The late P. Secchi pointed out that certain characteristic movements of the compass, not merely accompany, but precede, grave atmospheric perturbations, even when the barometer is not affected.

No. 16, December 29, 1881.

Dr. Hélot, of Bolbec, gives a case of an epidemic of diphtheria in a previously healthy village near Caux. A tripe dealer had thrown quantities of animal refuse into a pond near his house, and when it was denounced as a nuisance the mud and the water were applied to the land as manure. A severe epidemic of diphtheria broke out, and lasted six months. A similar error was committed a second time and with the same results.

The Abbé Moigno asks for the loan of 10 grms. of cesium to enable a young chemist of his acquaintance to make some important experiments, and engages that it shall be afterwards returned.

Bulletin de la Société Chimique de Paris,
Tome 37, No. 1, January 5, 1882.

Normal α -Amido-valeric Acid.—V. Juslin.—This acid is very soluble in water, sparingly soluble in alcohol, and almost insoluble in ether. It sublimes without de-

composition. It crystallises in long colourless prismatic needles. Its composition is expressed by the formula, $C_5H_{11}NO_2$.

Manufacture of Potassium and Sodium Carbonates by the Direct Transformation of Chlorides by Trimethylamin.—J. Ortlieb and A. Müller.—The Solvay process for the manufacture of sodium bicarbonate is known to be inapplicable to the preparation of the corresponding potassium salt. The authors propose to effect the transformation by using trimethylamin in place of ammonia. Their patented process is in action at the Chemical Works of Croix, near Lille.

MISCELLANEOUS.

The Purification of Water.—A method of purifying water, which bids fair to place dyers, calico printers, bleachers, paper and other manufacturers, and public water boards (who have now only a supply of inferior discoloured water) practically in the position of those who have a first-class source of supply, has, after numerous investigations and experiments, been developed into a practical process by Mr. Peter Spence, of the Pendleton Alum Works, and has during the last few weeks been tested on a very large scale at the waterworks of the Bolton Corporation. The Bolton water, as supplied to the ratepayers, outlying local boards, and manufacturers (compensation) contains a proportion of micaceous clay in such a peculiar state of suspension that neither filtration nor long settlement in reservoirs will remove its dirty opaque tint; probably no water, therefore, could have put the process to a more severe test. The trial referred to has been made at the Heaton Reservoir, one of the two service reservoirs supplying Bolton and district; the other, the Sweetlove's Reservoirs, has been left untouched. The result of the trial is that, whereas the latter contains a mass of water which, upon being looked at through the two-foot tube, over white paper, would be pronounced unfit for human beings to drink, the Heaton reservoir now contains some sixty million gallons, which is beautifully transparent and colourless, and has, in fact, a much finer appearance than the Manchester water. It may be added that this result has been achieved without hardening the water or introducing any new constituent into it (the iron naturally present is, in fact, removed by the process—a most important point for dyers and printers), or without in any way affecting the fish in the reservoir; and the cost of treatment so far has been proved not to exceed one half-penny per head per annum of the population. The Bolton Waterworks Committee have shown commendable enterprise in affording an opportunity for testing the process upon so large a scale, as they had incurred great expense in connection with a bill for parliamentary powers to borrow a large amount of money for filtering operations. They had also with this process to face the serious difficulty in the eyes of water engineers that the clay precipitated by it would be deposited at the bottom of their service reservoirs. Their venture has now been rewarded by the gratifying discovery that filtration has been proved an unnecessary and useless expense, and that at the least favourable estimate it would be some fifty-two and half years before one foot of clay had accumulated at the bottom of their reservoir. In the case of Manchester water the impurity is mainly in solution rather than in suspension, the peaty matter giving the water, in the two-foot tube, the disagreeable yellow tint which is so conspicuous over the white tile flooring of the public baths, and which, because it prevents bathers knowing whether the water is really clean, doubtless deters many from patronising them. According to the experiments of Dr. Angus Smith, of Manchester, who is probably the greatest living authority upon the impurities of air and water, and who, we learn, has a high opinion of this new mode of purification, the

comparative results are:—Distilled water, 33; Manchester water treated, 32; and Manchester water untreated, 14. Dr. Smith considers, moreover, that a notable proportion of the pernicious though invisible albuminoid matters would be removed along with the coloured and mechanical impurities. For manufacturers in Lancashire and Yorkshire this process has its chief interest in the fact that it throws down not only clayey and dissolved peaty matter, but the dye, tan, excreta, and other liquid refuse now poured in such volumes into our rivers. The black Irwell, Irk, and Medlock waters are completely decolourised by it; and thus any manufacturer who has a good sized reservoir, and is prepared to incur the expense of the new process, might locate himself at any point of our great sewer rivers and get as much good water out of these foul streams as he practically requires. In illustration of this statement it may be mentioned that the East Lancashire Paper Mill Company at Radcliffe has employed the process for many months. They state:—"In the hot and dry weather our water was often very bad and heavily charged with the refuse from bleach and dye works higher up the river; in fact, on a hot summer's day the smell in the mill was so unpleasant as to be hardly bearable, especially when the beating engine was partly filled with water previously to filling it." They add that since using the process "there is no smell whatever, and the water after being filtered is as clear as spring water." It may be mentioned that where the reservoirs are sufficiently large to deposit all the precipitate, filtration is quite unnecessary. Last, not least, the process has a direct bearing upon the important question of the prevention of the pollution of our rivers and streams. It has now been proved beyond controversy that if the waste liquid refuse of our manufactories and public sewers is dealt with in large settling tanks, the impurities can be readily precipitated, and a clear and colourless effluent obtained for the rivers. At two towns where the sewage is so treated by the precipitation process, and where Mr. Spence's material is employed, this result is now being regularly realised. But the process, however practically successful, will certainly not come into general adoption until the legislative screw is more vigorously applied. Various manufacturers and public authorities have, it appears, had their attention drawn to the new process, but we understand the reply given in every case is, "We shall not incur any more expense until we are absolutely compelled."

MEETINGS FOR THE WEEK.

- MONDAY, 20th.**—London Institution, 5.
— Medical, 8.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
- TUESDAY, 21st.**—Institute of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.
— Society of Arts, 8. "Remarks on the Condition and Characteristics of some of the Native Tribes in the Hudson Bay Territories," by John Rae, M.D., LL.D., F.R.S.
- WEDNESDAY, 22nd.**—Society of Arts, 8. "The Tonic Sol-Fa System," by J. Spencer Curwen, A.R.A.M.
— Geological, 8.
- THURSDAY, 23rd.**—Royal, 4.30.
— Philosophical Club, 6.30.
— Royal Institution, 3. "Resemblances of Sound, Light, and Heat," by Professor Tyndall.
— Society of Arts, 8. "Some Practical Aspects of Recent Investigation in Nitrification," by R. Warington, F.C.S.
- FRIDAY, 24th.**—Royal Institution, 9. "Electric Railways," by Prof. W. E. Ayrton.
— Quekett Microscopical Club, 8.
- SATURDAY, 25th.**—Royal Institution, 3. "Volcanoes," by Prof. H. G. Seeley.
— Physical, 3. "Effect of Temperature on the Electrical Resistance of Mixtures of Carbon and Sulphur," by Shelford Bidwell. "Measurement of Curvature and Refractive Index," by C. Vernon Boys.

THE CHEMICAL NEWS

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25 MAR 82

ON THE SULPHATES OF ALUMINIUM.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon,
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In November, 1880, I had the honour of presenting to the Chemical Society the account of an investigation on the basic sulphates of iron (*Chem. Soc. Journ.*, 1880, 807), this being the first step of a research by means of which it is hoped that some light may eventually be thrown on those interesting but hitherto uninvestigated substances known as basic salts, and perhaps on molecular compounds in general. Thanks to a grant from the Government Research fund, made to me by the Royal Society, I have been enabled to continue this work, and now publish the results of some experiments on the sulphates of aluminium.

According to the existing literature of the subject, the basic sulphates of iron and aluminium are unparalleled amongst other salts for their number, and perhaps also for the ease with which they may be obtained. Those of aluminium are indeed not quite so numerous as the ferric sulphates, not more than nine having been described; but according to the present investigation, the fate of these nine sulphates should be similar to that of fourteen out of the fifteen basic ferric sulphates, it seeming highly doubtful, and in many cases being satisfactorily disproved, that any particular one of these bodies is a definite chemical compound.

I. The Aluminium Sulphate used.

It was found that all specimens of aluminium sulphate which were procurable in commerce contained a certain amount of potassium-alum as an impurity, and in order to obtain a pure substance it was necessary to concentrate a solution of the commercial substance till it partially crystallised, and filter off the remaining solution from the alum which by this process had separated out.

The solution employed in the following experiments was one which was nearly saturated at 0° C., and contained 16.614 per cent of the anhydrous sulphate, or 0.1955 grm. per c.c., its density was found to be 1.1767, and on a determination of the ratio of aluminium oxide and sulphur trioxide present being made, the following numbers were obtained:—

		I.	Found.	II.	Theory.* Per cent.
Al ₂ O ₃	.. ..	29.744	29.923	29.848	
SO ₃	.. ..	70.256	70.077	70.152	

Showing that the sulphate was free from excess of either acid or base. Very small traces only of potassium could be detected in it.

II. Method of Analysis and Washing of the Basic Sulphates

In analysing a solution of one of these basic sulphates in hydrochloric acid, it was found to be practically impossible to precipitate the sulphur before the alumina, as in the case of the ferric sulphates, the presence of aluminium in the solution causing the barium sulphate to pass through the filter. Happily, however, the aluminium hydrate precipitated from a solution containing sulphuric acid is not very difficult to wash. In an analysis, therefore, the aluminium was precipitated first with excess

of ammonia, the solution boiled* till it became neutral, the precipitate washed slightly, re-dissolved in hydrochloric acid, and then re-precipitated, the alumina being found, after this second precipitation, to be perfectly free from combined sulphuric acid. After the barium sulphate had been precipitated, traces of the aluminium were still found in the solution, and these were estimated by evaporating the liquid with ammonia and igniting the residue. The evaporations were conducted in platinum vessels.

This method of analysis admits of many sources of experimental error. To determine the extent of this error several analyses of pure alum were performed, and it was thus ascertained that the percentages given in this paper might err from the truth by as much as 0.3, although in the majority of cases they might be relied upon to within half of this amount.

Another source of inaccuracy presented itself, as in the case of the sulphates of iron. All the basic sulphates of aluminium are decomposed slowly on being washed with water, but, unlike the ferric sulphates, they yield a portion of their base as well as of their acid to the wash-water.

The ratio of the base to the acid thus dissolved was found to be about 20 : 80, which ratio varied but slightly in various cases; therefore this decomposition affected by the wash-water tends to render all the precipitates more basic than they were when first precipitated.

The precipitates were washed till the wash-water gave a slight cloudiness with barium chloride only after standing for some seconds, it having been found that after this point had been reached the sulphate in the wash-water continued to be nearly constant. About 100 c.c. of wash-water were usually required to effect the washing of 0.1 grm. of the basic sulphate.

Several determinations were made in order to ascertain the amount of the decomposition effected by the water, and though it was not found to be great, it was, however, appreciable, and would render all the percentage of alumina found somewhat higher than they should be. The general conclusions, however, arrived at in this paper will not be much affected by this fact, for, as it will be seen, they depend less on the non-concurrence of the analytical numbers with the composition of definite compounds than on proving that a continuous alteration in some one of the factors of the experiment produces a continuous variation in the composition of the precipitate formed.

Since the water contained in these basic sulphates seemed to be very variable, as in the case of those of iron, and to afford us no aid in attaining the ends in view, the precipitates were not dried,† but were analysed as soon as they had been washed in the manner detailed above, the ratio of the alumina and sulphuric anhydride present being alone determined.

III. Precipitation with Sodium Carbonate.

The tendency to form basic sulphates is certainly not so great in the case of aluminium as in that of iron, for a solution of the normal sulphate of the former of these metals remains perfectly clear when diluted with an indefinite amount of distilled water, and even where ordinary water is used, it requires an extremely large quantity of it to produce any visible cloudiness.

Series of experiments were made in which varying amounts of aluminium sulphate were treated with varying amounts of sodium carbonate solution, the proportion of water present being also varied. The results thus obtained are represented diagrammatically in the accompanying plate. The curves Nos. 1, 2, and 3 show the composition of the precipitates which are formed in the various cases.

* Unless the ammonia is entirely expelled in this way, as much as 5 per cent. of the alumina may remain in solution.

† An operation which was found to require many weeks at low temperatures, and to entail a loss of acid at higher ones.

* Al=27.02. See the recent determinations of the atomic weight of aluminium, by Mallet (*CHEM. NEWS*, vol. xli., p. 212).

The action here appears to be very different from what it is in the case of ferric sulphate; instead of a definite basic salt being precipitated by the addition of any quantity of the alkaline carbonate within certain limits, there is here a gradual decrease in the basicity of the precipitate followed by gradual increase until it finally consists of nothing but pure alumina, the quantity of sodium carbonate then added amounting to about 3.5 molecules (twice as much as in the case of iron) for every molecule of the normal sulphate taken. By comparing together any points in one of these curves with those vertically above or below it in the others, we see that an alteration in the amount of water present increases or diminishes the basicity of the precipitate according to the different points selected in the curves, and at no point is the influence of the water very great. The curves 4, 5, and 6

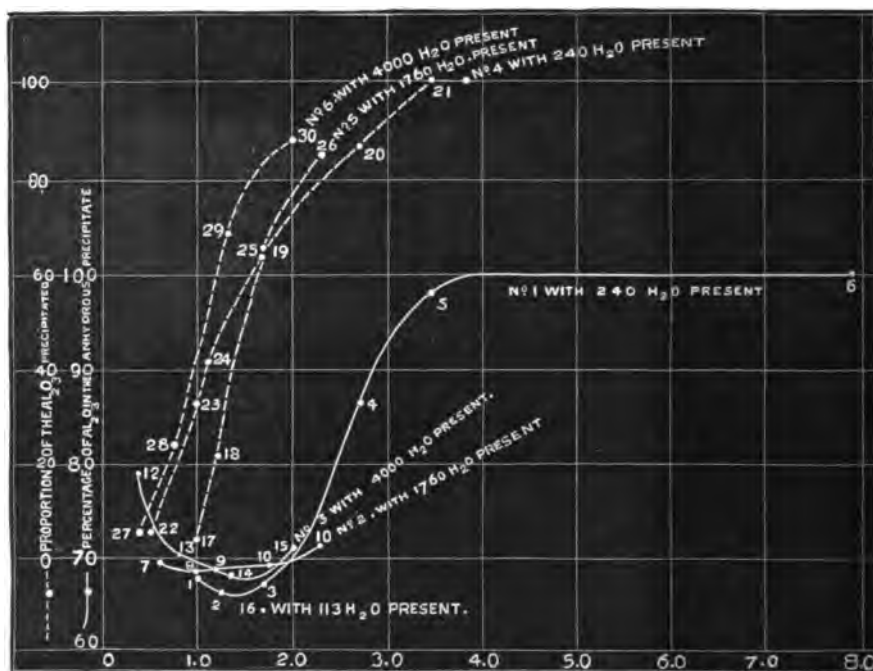
water present. The lowest portions of the curves indicate a basic body varying between the limits of $3\text{Al}_2\text{O}_3, 2\text{SO}_3$, which contains 65.69 per cent of Al_2O_3 , and $5\text{Al}_2\text{O}_3, 3\text{SO}_3$, which contains 68.02 per cent. of Al_2O_3 , or perhaps $2\text{Al}_2\text{O}_3, \text{SO}_3$, which contains 71.85 per cent of Al_2O_3 .

IV. Precipitation by Ammonia.

Maus (*Pogg. Ann.*, xi., 80) states that by addition of potash and ammonia to solutions of potassium and ammonium alum respectively, solutions of basic double sulphates were obtained; in one case in which the potassium compounds were used, the solution on standing deposited a precipitate of $\text{Al}_2\text{O}_3, \text{SO}_3$; no analytical numbers, however, are given.

In order to ascertain the nature of the action of an alkali on aluminium sulphate, the experiments given in

ALUMINIUM SULPHATE TREATED WITH VARYING AMOUNTS OF SODIUM CARBONATE IN THE PRESENCE OF VARIOUS AMOUNTS OF WATER.



Molecules of Na_2CO_3 added to each Molecule of $\text{Al}_2(\text{SO}_4)_3$.

show approximately the amounts of alumina contained in the precipitates, as compared with the total amounts in the solution taken; it will be seen that the amounts thus precipitated vary between 4 and 100 per cent., while the point at which all the alumina is thus precipitated corresponds very nearly to that at which the precipitate first consists of pure aluminium hydrate. An increase in the amount of water present increases the actual amount of precipitate obtained, but not to any very large extent.

In these experiments the precipitates were not filtered off from the solutions until five days after the addition of the carbonate, which, in the majority of cases, was three days after the solution had ceased to give off carbon dioxide. In no case were the precipitates found to contain any appreciable amount of sodium or of carbonate.

Thus it is seen that the precipitation of aluminium sulphate by an alkaline carbonate affords no evidence whatever of the existence of any definite basic sulphate of this metal; the composition of the precipitate varies with the proportion of alkali added and with the amount of

Table I. were made, ammonia being the alkali used. In the first four experiments, increasing quantities of ammonia were added to various portions of the sulphate, and the precipitates were filtered off after the lapse of a few minutes; in the last of these experiments (34) a considerable excess of ammonia was present. The results here obtained indicate that the precipitate increases gradually in basicity as the quantity of alkali added is greater.

As the precipitate first deposited dissolves to a considerable extent when allowed to remain in the liquid, two other experiments were performed similar to the previous ones, except that the liquid was filtered immediately after all the ammonia had been added. The results of these experiments (35 and 36) point to a diametrically opposite conclusion, the more basic precipitate being obtained on the addition of the smaller amount of alkali.

The problem was then attacked in a different manner, a quantity of the sulphate was taken and precipitated

TABLE I.
Precipitation of Aluminium Sulphate with Ammonia.

	Al ₂ O ₃ in the precipitate; that in the solution taken being 100.	Percentage of Al ₂ O ₃ in the anhydrous precipitate.
31.	9	71'324
32.	53	74'44
33.	92	89'939
34.	100	98'835
35.	13'1	76'328
36.	16'4	74'14
37.	5	71'119
38.	21	69'494
39.	21	67'17
40.	24	67'345
41.	22	68'519
42.	7	90'86

fractionally with ammonia. As it was found that the tendency of the precipitate to re-dissolve was considerably diminished by increasing the amount of water present, the solution here taken contained only 0.196 per cent of the sulphate instead of about 9 per cent., as in the previous cases. Even here, however, it is seen that a very considerable re-solution takes place, each precipitate given in the table being obtained by the addition of equal quantities of ammonia. In the last of these experiments (42) the alkali was present in slight excess. The results here obtained are curious, and when represented diagrammatically form a curve very similar both in general form and in position to those obtained from the experiments with sodium carbonate. The precipitate decreases at first in basicity, and after remaining for some time (during the precipitation of 45 per cent of the alumina) practically constant in composition, becomes more basic, till it consists of almost pure aluminium hydrate. But even the apparent constancy in composition of the precipitate in the experiments 39 and 40 cannot be assumed to be real, for both these precipitates may very well consist of some less basic substance mixed with one approaching in composition to that of experiment 38 on the one hand, and that of 41 on the other. Moreover, a sulphate containing about 67.25 per cent alumina does not correspond sufficiently closely to any definite chemical compound even to suggest its being such.

To a 49 per cent solution of alumina sulphate small portions of ammonia were added during the course of three days till the precipitate no longer re-dissolved. The solution, after having been filtered and set aside for four or five days, was found to have deposited a precipitate, which on analysis proved to contain 67.75 per cent of alumina. The filtrate continued to form a further deposit for some weeks longer.

These experiments, therefore, afford no confirmation whatever of Maus's statement that the sulphate Al₂O₃.SO₃ (containing 56.06 per cent of Al₂O₃) is obtained by the treatment of the normal sulphate with an alkali, nor do they tend to show that the precipitates which are really formed in this reaction are definite chemical compounds at all.

(To be continued.)

Formation of Two Bibasic Acids, the Sebacic and Suberic, in the Distillation of Crude Fatty Acids in a Current of Superheated Steam.—A. Cahours and E. Demarçay.—The distillation of crude fatty acids in a current of superheated steam splits them up into saturated hydrocarbons, homologues of marsh-gas, in acids of the acetic group belonging to the normal series, and finally into two bibasic acids, homologues of succinic acid, i.e., the suberic and sebacic, compounds which are formed on submitting fatty acids of high molecular weights to oxidising agents.—*Comptes Rendus*.

ESTIMATION OF ALKALOIDS BY POTASSIUM MERCURIC IODIDE.

By ALBERT B. PRESCOTT.

(Concluded from p. 115.)

Regarding the Iodomercurate Precipitation of Atropine, Mayer states* that the precipitate is (C₁₇H₂₃NO₃HI)₂HgI₂, "one-half the mercury of the test-liquor remaining in solution." He also makes the same remark again, thus† "The compounds formed are hydriodates of the base with iodide of mercury; in consequence of which [?] a part of the mercury used for precipitation remains in solution." How it could be true that any part of the mercury used for precipitation remains in solution I am unable to understand, and qualitative tests indicate that it is not true. When Mayer's solution is added to alkaloid acidulate solution, not quite to complete precipitation of the alkaloid, and filtered, the filtrate yields no mercury beyond that trace due to the water solubility of the precipitate itself. Charging the filtrate with hydrogen sulphide, the solution is but slightly darkened, with no precipitate, and the same slight darkening is obtained with hydrogen sulphide in the final water washings of the precipitate. (The mercury of Mayer's solution is changed to precipitate of mercuric sulphide by action of hydrogen sulphide, and so is that of the alkaloid iodomercurate precipitates.) This evidence that no part of the mercury of the reaction is left in solution was obtained with quinine, morphine, aconitine, and atropine; and obtained, alike, with Mayer's solution as it is, and with Mayer's solution which had been saturated with mercuric chloride.

It certainly appears, then, that all the mercury of a potassium iodide solution, as well as all the iodide essential to the solubility of the same, enter into the precipitates with the alkaloids,—save only such traces as correspond to the solubility of these precipitates. In accord with this conclusion, regarding the iodide, the equation for strychnine precipitation was proposed with—



for Mayer's solution. Now, regarding the mercury—the element never in excess in our reagent—it has to be admitted, when we disprove Mayer's inexplicable statement for the atropine precipitation, that "one-half the mercury of the test-liquor remains in solution," we return to an apparent dilemma—a contradiction as to the ratio between atropine and mercury, as follows:—

C₁₇H₂₃NO₃ to Hg, from volumetric indications: Mayer, 0.0145; Dragendorff, 0.0125; Günther, 0.0193; the ratio varied by conditions; the precipitate somewhat soluble.

2C₁₇H₂₃NO₃ to Hg, from gravimetric indications: Dragendorff, 0.0375 alkaloid giving 0.0379; 0.0375 giving 0.0386; 0.0420 giving 0.0409, &c., quite uniform. (Precipitate: alkaloid: : 100: 44.9.)

The above atomic ratio for volumetric use is that of 0.0145 atropine to each c.c. of the standard solution: 1-20,000th of C₁₇H₂₃NO₃ (289) to 1-20,000th of HgI₂+4KI (HgCl₂ 271 and KI 996.6). Mayer gave this, theoretical, as the working factor.‡ Dragendorff reports§ a large number of results, pretty uniform for 0.0125 atropine to each c.c. of alkaloid, when the conditions were kept as follows: The dilution 350 to 500 parts for one of alkaloid; the Mayer's solution diluted with an equal bulk of water; the addition so slow that the precipitate may crystallise; the end of the reaction found by filtering a few drops and adding thereto a drop of the standard solution, and a correction made by adding 0.00005 grm. alkaloid for each c.c. of total solution. Günther, using a method of Dragendorff's, reports|| 0.0193 to the c.c.

* CHEMICAL NEWS, vii., 161.

† *Ibid.*, 159.

‡ *Ibid.*, 159, 160.

§ Werthbestimmung, Seite 20. Also, in part, Dragendorff and Koppe, *Zeit. An. Chem.*, 6, 309, (1867).

|| *Zeit. f. an. Chem.*, 6, 476 (1869).

For the atomic ratio found in gravimetric analysis of the atropine precipitate, having only half as much mercury to alkaloid as Mayer's volumetric ratio, I can only cite the experiments of Dragendorff,* but they seem to be sufficient. The atropine, in acidulate solution of 350 to 400 parts, is precipitated by a slight excess of Mayer's solution, the precipitate left twenty-four hours to subside, well washed, dissolved in alcohol, and this evaporated to dryness at 100° C. Eight trials are reported, with results ranging as quoted above. Mayer gives no data for the formula he states, $(C_{17}H_{23}NO_3HI)_2HgI_2$. The discrepancy, then, is to be acknowledged as an admonition to return to further investigation. The molecular formula of atropine obtains support from the late synthetic advances of Ladenburg;† but it is an alkaloid liable to decomposition, and consequent impurity, whereby our perplexity may have arisen. Also, the composition of the iodomercurate may change in being washed with water.

In the Precipitation of Morphine as iodomercurate, it is well established that, when the dilution is 200 parts of acidulate solution for 1 part of alkaloid, each c.c. of Mayer's solution precipitates very nearly 0.020 of morphine crystallised, or 0.019 of morphine anhydrous. The alkaloidal crystals, $C_{17}H_{19}NO_3 \cdot H_2O = 303$, are constant on the water-bath, becoming anhydrous, $C_{17}H_{19}NO_3 = 285$, at 120° C. The factor 0.020 to the c.c. was given by Mayer, and is sustained by Kubly and Dragendorff, who make the proviso that the dilution should be 200 to 1.‡

In trials that I have made with crystallised morphine I have found the ratio of 0.020 to 1 c.c. to give results coming near to the quantity taken, but apt to fall a little below.§ The solubility of the precipitate must not be disregarded: in dilutions of 1 to 4000 the reaction does not appear. In the ratio of 0.0202 grm. crystallised morphine to the c.c. we have 0.0202 of $2C_{17}H_{19}NO_3 \cdot H_2O$ for 0.0202 of $(HgI_2 + 4KI)$ in Mayer's solution; or 4 molecules of alkaloid for 3 atoms of mercury, indicating for the precipitate $(C_{17}H_{19}NO_3)_4(HI)_x(HgI_2)_3$.

The following analyses of the precipitate were made by Messrs. Judson and Payne, following the method previously reported—the same used for strychnine.

	Calculated from $(C_{17}H_{19}NO_3)_4(HI)_x(HgI_2)_3$	1st.	Judson and Payne. 2nd.	3rd.	Mean.	Calculated from $(C_{17}H_{19}NO_3)_4(HI)_x(HgI_2)_3$
Iodine ..	1270 42.13	42.6	43.0	41.7	42.43	1524 46.61
Mercury ..	600 19.92	17.5	18.0	19.7	18.40	600 18.35
H of HI ..	4 0.13	—	—	—	0.13	6 0.18
Morphine..	1140 37.82	—	—	—	39.04	1140 34.86
	3014 100.00				100.00	3270 100.00

Groves (*loc. cit.*) obtained a mean of 42.27 per cent iodine and 22.74 per cent mercury, leaving 32.91 per cent morphine. His proposed formula was $C_{17}H_{19}NO_3 \cdot HgI_3$.

In comparison, it may be noted that morphine forms $(C_{17}H_{19}NO_3)_2(HCl)_2PtCl_4$, $(C_{17}H_{19}NO_3)(HCl)(HgCl_2)_2$, and $(C_{17}H_{19}NO_3)_4I_6$.

For morphine, then, gravimetric and volumetric experi-

* "Werthbestimmung, Seite 24. Another report may be mentioned, one made by the present writer, in 1876, from the work of Mr. J. R. Little (*Am. Jour. Pharm.*, 48, 388: *Jahresbericht der Pharmacie*, 1876, 526). As the absolute purity of the alkaloid taken was not made certain, the object being that of approximate assay, I could not quote the results as important in this enquiry. In triplicate trial, 0.100 of atropine gave 0.170 of precipitate. The precipitate was simply water-washed and dried.

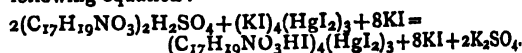
† *Deut. Chem. Ges. Ber.*, 12, 941, 944.

‡ "Werthbestimmung starkwirkender Drogen," S. 86. *Zeit. Analyt. Chemie*, 6, 321. Results as follows:—

1st. 0.0224 cryst. morphine to the c.c. in feebly acid sol.
2nd. 0.0221 " " " strongly "
3rd. 0.0191 anhyd. " " " feebly "
4th. 0.0205 " " " strongly "

§ The writer's report on Morphometric Processes for Opium, *Pro. Am. Phar. Assoc.* (1878), 26, 812; *Jour. Chem. Soc.* (1880), Abstracts, 1.

ments, with the test for iodine in the filtrate, admit the following equation:—



In the Quinine Precipitation, it is stated that 1 c.c. of Mayer's solution precipitates 0.0108 grm. of anhydrous alkaloid. I am unable to cite any volumetric determinations in support of this ratio. The anhydrous alkaloid is obtained at 125° C. The crystallisation water of the sulphate is not uniform. The factor 0.0108 is 0.0108 of two-thirds the molecular weight, 324, and indicates the molecule of the precipitate to be $(C_{20}H_{24}N_2O_2)_2(HI)_x(HgI_2)_3$. The percentages obtained by Messrs. Judson and Payne do not accord with this formula, whether we take two, three, or four of (HI). The following is a comparison of one of these formulæ:—

	Calculated from $(C_{20}H_{24}N_2O_2)_2(HI)_x(HgI_2)_3$	Judson and Payne. 1st.	2nd.	3rd.	Mean.
Iodine—	1143 47.74	47.10	48.30	47.80	47.73
Mercury—	600 25.06	20.90	20.10	19.60	20.20
H of HI—	3 0.13	—	—	—	0.13
Quinine—	648 27.07	—	—	—	31.94
	2394 100.00				100.00

Some time since, a determination of the weight of iodomercurate precipitate of quinine, made by Messrs. Johnston and Lobb, was reported by the writer.* The quinine taken was dried, from the trihydrate, at 100° C. The precipitate was washed, and dried at 100° C. There were obtained—

1st, from 0.280 of quinine, 0.801 of iodomercurate
2nd, " 0.280 " 0.824 "
3rd, " 0.280 " 0.812 "
Mean " 1.000 " 2.900 "

If we accept the proportion of 4.28 per cent of water retained in quinine hydrate dried on the water-bath (Allen,

referred to, *Ibid.*), we have 2.485 of precipitate from 1.000 of anhydrous quinine; or 33.01 per cent of alkaloid in the precipitate, against the 31.94 per cent of Judson and Payne. Groves† obtained a mean of 23.25 per cent of mercury, and 46.60 per cent of iodine, in the precipitate.

From the Berberine Precipitate Messrs. Judson and Payne obtained a mean of 4.17 per cent (40.8, 41.0, 37.7) of iodine, and a mean of 7.73 (7.5, 7.7, 8.0) per cent of mercury, leaving a mean of 52.10 per cent of alkaloid. In 1876 I reported‡ some results of work by Mr. Beach, giving very nearly 2 parts iodomercurate from 1 part of berberine. Excess of the standard solution did not vary the weight of the precipitate.

Certainly it is desirable to have analyses of these precipitates with direct estimations of the alkaloids in them, otherwise the question of hydration is unsettled. The quantity of precipitate made from a solution of a unit of

* *Am. Jour. Pharm.*, 49, 482 (Oct., 1877); *Jahresbericht der Pharm.*, 1877, 419; *Phar. Jour. Trans.* [3], 5, 407.

† *Jour. Chem. Soc.*, 11, 101.

‡ *Am. Jour. Pharm.*, 48, 385; *Jahresbericht der Pharm.*, 1876, 524.

alkaloid becomes an uncertain datum in most cases, owing to a degree of solubility of the precipitate.

Some determinations of the proportions of iodide and mercuric salt needful for solutions were made by Mr. Hugo Lupinski,* and should be here reported. Four twentieth-normal solutions were made, as follows:—

No. 1.—Mercuric chloride, 13.55; potassium iodide, 33.22; water to 1 litre. $\text{HgCl}_2 + 4\text{KI} = \text{HgI}_2 + 2\text{KI} + 2\text{KCl}$. Some red mercuric iodide remained undissolved. This dissolved when heated, and crystallised on cooling.

No. 2.—Mercuric chloride, 13.55; potassium iodide, 33.22; potassium bromide, 2.9825; water to 1 litre.

$\text{HgCl}_2 + 4\text{KI} + \frac{1}{2}\text{KBr} = \text{HgI}_2 + 2\text{KI} + \frac{1}{2}\text{KBr} + 2\text{KCl}$. Complete solution required heat, and on cooling there was a crystalline deposit of red iodide of mercury.

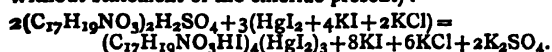
No. 3.—Mercuric chloride, 13.55; potassium iodide, 33.22; potassium bromide, 5.965; water to 1 litre.

$\text{HgCl}_2 + 4\text{KI} + \text{KBr} = \text{HgI}_2 + 2\text{KI} + \text{KBr} + 2\text{KCl}$. Dissolved readily, and did not deposit on standing four weeks.

Solution No. 3 was used, with the idea that it furnished potassium mercuric iodide of the more stable composition of $(\text{KI})_2\text{HgI}_2$, with no excess of iodide, and in a permanent solution. It was thought that, with most alkaloids, the bromide would not react at all.

Using this solution, No. 3, Mr. Lupinski made a diligent search for an indicator of the end of the reaction, with alkaloids:—(1) A paper wet with saturated mercuric chloride and dried was used—to reveal the presence of an excess of the standard solution in estimation of alkaloids. The indicator worked well, except that it was not delicate enough. (2) A solution of potassium and ammonium hydrates, to give the mercurammonium iodide, when excess of the reagent was attained, with alkaloid acidulous solutions. The alkali hydrates react with the alkaloid precipitates, and therefore do not serve. (3) A solution of iodic acid and starch, to show when excess of soluble iodide had been attained. This, too, reacted with the precipitates, and was inoperative.

A proposition was made by Mr. Mayer† to find the end of the reaction by adding excess of the Mayer's solution, and then "without filtering" titrating back with tenth-normal solution of silver nitrate, using normal chromate of potassium as an indicator in the common way. Each c.c. of the standard potassium mercuric iodide to require 4 c.c. of the corresponding silver solution. Mr. Lupinski‡ calls attention to the essential defect in this plan, that it disregards the accumulation of the potassium chloride of Mayer's solution during the precipitation of alkaloids. Also, the excess of potassium iodide would interfere in the same way. The erroneous results of titrating back with Mayer's solution may be placed before the eye by an equation for the morphine precipitation (given before without statement of the chloride present):—



With no excess of the Mayer's solution, there are still $8\text{KI} + 6\text{KCl}$ to titrate back with the silver solution. Mr. Mayer offers this use of the silver solution, "where no colouring matters, or substances affecting nitrate of silver, are present." On trial some time ago I found that some of the alkaloid iodomercurate precipitates gradually decompose silver nitrate in solution by contact at common temperatures.—*American Chemical Journal*.

Oxygen.—It is said that MM. Brin have greatly improved Boussingault's process for the manufacture of oxygen by alternately peroxidising and re-oxidising barium oxide. The material employed after being re-used 400 times was found not to be deteriorated. MM. Brin calculate on being able to supply oxygen on the large scale at 12 to 15 centimes per cubic metre.—*Les Mondes*.

* "Graduation Thesis," Univ. Mich., 1878.

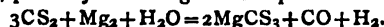
† *CHEMICAL NEWS*, vol. vii., p. 159.

‡ "Thesis," before cited.

MAGNESIUM AND SODIUM THIOCARBONATES.

By I. TAYLOR, Christ Church, Oxford.

Magnesium Thiocarbonate may be prepared in the following manner:—A strip of magnesium ribbon is coiled about a piece of platinum foil, which is placed in a flask, and covered half with carbon disulphide, the remaining half with water. In a few hours the water acquires a light yellow tint, which deepens in two or three days to a bright golden yellow. Magnesium thiocarbonate is formed, carbon monoxide and hydrogen gases being at the same time evolved, probably according to this equation—



The same decomposition occurs, but more slowly, if a spiral of magnesium ribbon is used without the platinum foil.

Sodium Thiocarbonate may be obtained by decomposing water, in presence of carbon disulphide, with sodium amalgam. Carbon disulphide is placed in a flask and water added, then a quantity of sodium amalgam. The flask is shaken well. Sodium thiocarbonate is rapidly formed, carbon monoxide and hydrogen gases being evolved, probably thus—



LOCH KATRINE WATER.

THE annual report on Loch Katrine water, prepared by Professor E. J. Mills, D.Sc., F.R.S., of the Young Laboratory of Technical Chemistry, Anderson's College, has been published. The report refers to the twelve months from March, 1881, to February, 1882, inclusive. The composition is represented in parts per 100,000; these numbers can be converted into grains per gallon by multiplying by 0.7. The mean composition and mean departure therefrom are as follow:—

	Com- position.	Mean depar- ture.	Mean departure per cent.
Total solid impurity	3.001	0.073	2.4
Organic carbon	0.140	0.009	6.4
Organic nitrogen	0.017	0.003	11.1
Ammonia	0.000	0.000	0.0
Nitric nitrogen	0.008	0.001	12.5
Total combined nitrogen ..	0.025	0.003	12.0
Chlorine	0.63	0.024	3.8
Hardness (total)	0.99	0.08	8.0
Mean			7.03

By way of contrast the corresponding figures for last year are appended:—

	Com- position.	Mean depar- ture.	Mean departure per cent.
Total solid impurity	2.938	0.071	2.4
Organic carbon	0.133	0.020	14.9
Organic nitrogen	0.017	0.002	13.7
Ammonia	0.000	0.000	0.0
Nitric nitrogen	0.007	0.001	8.9
Total combined nitrogen ..	0.023	0.003	11.0
Chlorine	0.618	0.023	3.7
Hardness (total)	1.01	0.08	7.9
Mean			7.8

The average percentage variation during the last six years has been successively 56, 27, 13, 6.9, 7.8, 7.03.

Total Solid Impurity.—This was at a minimum (2.89 in July), and a maximum (3.12) in December. Its general character was such as to impart a pale brown colour to the water, with only a slight turbidity. Its average amount has been a little more than last year.

Organic Carbon.—This has increased 0.007 since last year. Minimum (0.127) in June; maximum (0.151) in February.

Organic Nitrogen.—Minimum (0.012) in July; maximum (0.027) in March.

Ammonia.—The continued entire absence of ammonia is a remarkable circumstance in connection with urban supply.

Nitric Nitrogen.—This element maintains its smallness and almost constancy of amount.

Total combined Nitrogen.—This was somewhat more than last year. Minimum (0.019) in July; maximum (0.034) in March.

Chlorine.—Chlorine continues to increase, being about 2 per cent higher than in the preceding annual period. Maximum (0.7) in February.

Hardness.—The saline compounds which impart hardness to this water are nearly the same in amount as last year. Maximum (1.2) in February; minimum (0.71) in April.

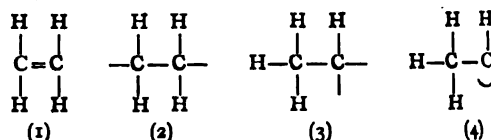
Dissolved Gases.—The amount of these has been once determined during the year, in January. The results are stated in volumes per cent.

Carbon dioxide.	Oxygen.	Nitrogen.	Total.
0.02	0.30	1.46	1.78

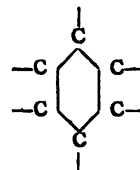
The carbon dioxide was remarkably low, and the oxygen rather low.

Temperature.—The minimum was 4° C. (=39.2 F.) in March. Maximum was 12.6° C. (=56.5 F.) in August. Mean, 8.6° C. (=47.5 F.).

ceptions a given radicle always manifests either an even or uneven valency, and not an even valency at one time and an uneven valency at another. These views are at the basis of our present system of writing developed rational formulæ. As an outcome of this, we have the division of compounds into atomic and molecular: the first consisting of those bodies for which rational formulæ may be constructed on the basis of certain hypothetical conceptions of the valency of the constituent elements; the second comprising all those for which rational formulæ cannot be thus constructed. The author then considered the hydrocarbons, as this class of bodies plays such an important part in modern theoretical chemistry. Our views of the constitution of the hydrocarbons are based on the assumption that in them carbon is uniformly a tetrad, and that methane, CH_4 , is to be represented by a symmetrical formula. It appears to be generally agreed that we are to regard the hydrocarbons of the paraffin, or $\text{C}_n\text{H}_{2n+2}$ series, as the parent series from which all other series of carbon compounds are more or less directly derived. As to the series C_nH_{2n} , the first term of this series is C_2H_4 . Now four formulæ may be assigned to C_2H_4 —



Now all attempts to produce a hydrocarbon of unsymmetrical constitution, as 3 and 4, have failed, and it has become almost a dogma to accept No. 1 as the correct formula. Whether we assign the formula 1 or 2 to ethylene, there can be but little doubt that only one of these forms of combination is possible, for we only know one ethylene. The first term of the $\text{C}_n\text{H}_{2n-2}$ series, acetylene, C_2H_2 , has by general consent the formula corresponding to No. 1 of ethylene. Acetylene has the remarkable property of forming metallic derivatives, and it seems that only one of the hydrogen atoms becomes displaced. The author then considered the $\text{C}_n\text{H}_{2n-6}$ series, which includes, besides the benzene series, dipropargyl, which behaves like an acetylene, but can exchange two atoms of hydrogen for metallic radicles, and has a considerably higher heat of combustion than benzene. The various formulæ proposed for benzene were then discussed, the least objectionable being the well-known formula of Kekulé; but on the whole the author prefers the formula first suggested by Lothar Meyer—



in which the carbon atoms have free affinities, and proposes a simple hexagon as the most satisfactory symbolic embodiment of our knowledge of benzene and its compounds. Lossen and Brühl have from somewhat different arguments also advocated this view. Lossen, moreover, states that in our present state of knowledge it is impossible to express in a rational formula more than this, viz., with what other atoms each individual atom in the molecule is directly united. Lossen defines valency of an atom as the number expressing how many atoms are directly combined with it. In this sense valency is variable; but experience shows that every polyad atom has a highest or limiting value, and, as the lower values are all included in it, in this sense valency is constant. The author then refers to the views of J. Thomsen on the constitution of benzene, and gives various reasons why as a chemist he dissents from his conclusions. Prof.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 16, 1882.

Prof. H. E. Roscoe, President, in the Chair.

THE following certificates were read for the first time:—W. J. Kemp, P. W. Squire, L. Taylor. During the evening a ballot was held, and the following gentlemen were declared by the Scrutineers, Drs. Plimpton and Thorne, duly elected Fellows of the Society:—H. S. Billing, J. Brown, H. H. Crawley, T. Donnelly, U. K. Dutt, W. Fowler, N. Graham, A. Hartley, A. Hill, R. Mar, J. T. Smith, F. Vacher.

Dr. ARMSTRONG read a paper "On Valency," with special reference to methods of writing rational formulæ, and the existence of so-called molecular, as distinct from atomic, compounds. The definition of valency, at present most in accordance with the views of the majority of chemists, is probably the following:—The valency of a radicle is its combining or displacing power in terms of hydrogen atoms, a radicle being monad, dyad, triad, or tetrad, according as it is capable of combining with or displacing one, two, three, or four atoms of hydrogen, or the equivalent amount of some other simple or compound radicle. Some chemists maintain that a given radicle has a fixed valency; others that valency is variable; but as the latter for the most part consider that the latent affinities of an unsatisfied radicle in some way neutralise each other, the difference is to a great extent one of words. It is remarkable that those who hold atomicity to be variable have hesitated to confer higher functions, for example, than pentadic on phosphorus, or hexadic on sulphur, and that only one element belongs to the class of octads. It appears to be very generally held that the valency of a radicle is not necessarily determined by reference to its compounds with monad elements, but that its compounds with polyad elements are also available. We are also accustomed to the statement that with few ex-

Hartley's results are also, in the opinion of the author, not conclusive as to the constitution of benzene. In conclusion the author briefly considered the question of double salts, as K_2PtCl_6 , K_2FeCl_4 , &c. The latter compound is undoubtedly a ferrous compound, but the chlorine might be polyvalent, and so hold the potassium on to the iron. Some of these so-called molecular compounds are more stable than the simpler atomic compounds. Thus $PtCl_4$ is a very unstable substance compared to K_2PtCl_6 ; and, again, $HClO_4 \cdot 2H_2O$ is more stable than $HClO_4$.

Dr. WRIGHT drew attention to a symbol for benzene, which, though resembling Ladenburg's, was essentially different. It represented the atoms of carbon as collected at the corners of a triangular prism. As regards the double salts it seemed to him that the polyvalency belonged to the chlorine rather than to the metal, and that the formulae might be written very similarly to those of the carbonates.

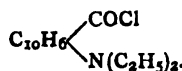
Mr. FISHER said that Dr. Armstrong, in discussing the formula of benzene, hardly seemed to have the courage of his convictions. The criterion of valency was the power of an element to combine with H: thus in acetylene carbon is a dyad, in ethylene a triad, &c. There was great danger of reasoning in a circle; if hydrogen be taken as the unit of valency, then in H_2O oxygen is a dyad, but in a compound like NO we have lost all connection with hydrogen, and it is best to say N and O are in this compound both monads, and so in benzene carbon is a triad. The double salts seemed in many cases to be truly atomic compounds. Thus if chlorine be passed into a solution of pure $PbCl_2$ no combination takes place, but if HCl or KCl be present a compound containing $PbCl_4$ is at once formed, and these compounds are quite stable, and are just as truly atomic compounds as $PbSO_4$.

The PRESIDENT said that the more we considered the subject the more difficult it seemed to come to a conclusion, either as to fixed or variable valency, and, as Dr. Williamson pointed out, valency seemed to be a function of temperature. In some respects valency had been of great use, as, for instance, in connection with Mendel-jeff's law.

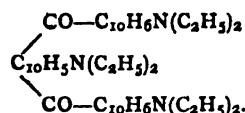
"On the Preparation of Diethyl-naphthylamine," by B. E. SMITH. The author prepared this substance by the action of ethyl-bromide upon naphthylamine, at 100° to 120° : it is a pale straw-coloured oil, boiling at 290° . By the addition of hydrochloric acid the hydrochloride was obtained, very soluble in hot water. Nitroso-diethyl-naphthylamine was also prepared. The properties and analyses of these bodies are given in the paper.

"On the Action of Sulphuric Acid upon Diethyl-naphthylamine at High Temperatures," by B. E. SMITH. A base $[C_{10}H_6N(C_2H_5)_2]_2$, crystallising in needles, was formed—an acid having the formula $C_{10}H_6N(C_2H_5)_2 \cdot SO_2OH$ was also studied.

"On the Action of Phosgene Gas upon Diethyl-naphthylamine," by B. E. SMITH. Three colourless crystalline bodies were obtained. Two were isomeric, having the formula—



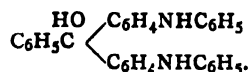
The formula of the third is—



"On some Constituents of Resin Spirit," by G. H. MORRIS. The author gives a *résumé* of previous researches on the subject. It has long been known that the lower fractions of resin spirit yield, on standing for some time, especially if loosely stoppered, a crystalline substance. These crystals have been analysed by Tichborne, Mills, and Anderson. The results of the author agree with those of Anderson. The crystals have the formula

$C_7H_{14}O_2 \cdot H_2O$. The anhydrous body, $C_7H_{14}O_2$, was also analysed; its vapour density, by Hofmann's method, was 63.6, theory requiring 65. These crystals are formed most plentifully by the fraction of resin spirit, boiling at 100° to 105° . The author succeeded in separating a hydrocarbon which had the formula $(C_7H_{12})_2$ of diheptene. Vapour density found 94.23. It is from this hydrocarbon that the above crystals are formed. The author has studied the action of nitric acid on heptene; the products are CO_2 , formic, acetic, butyric, and succinic acids, and a small quantity of dinitro-heptylene. The action of nitric acid, of acetic anhydride, and of bromine on the crystals has been investigated. The author concludes that the hydrocarbon heptene is probably methyl-propyl-allylene.

"Contributions to the Chemical History of the Aromatic Derivatives of Methane," by R. MELDOLA. In 1877, by the action of benzyl-chloride upon diphenylamine, the author obtained a viscid oily body, which, by oxidation with arsenic acid, formed a green colouring-matter, "viridin." Since that time the author has proceeded with the investigation of this reaction. The colouring-matter is the hydrochloride of a new base—



The diphenylamine green is produced by a reaction analogous to that by which malachite green is produced from its base. The base is thus diphenyl-diamido-triphenyl-carbinol. The diphenylamine green can be obtained more advantageously by employing benzo-trichloride. The salts of diphenylamine green are mostly insoluble in water. The author has examined the optical properties of the green, and the sulphonic acids produced by the action of sulphuric acid. He also discusses the constitution of the green and its relations. The author has studied some other products formed by the action of benzyl-chloride upon diphenylamine in the presence of zinc chloride. One of the products was a white pulverulent substance, phenyl-amido-diphenyl-methane, $C_{19}H_{17}N$; another, obtained by increasing the quantity of benzyl-chloride, was probably benzyl-phenyl-amido-diphenyl-methane, $C_{26}H_{23}N$. The action of benzyl-chloride upon aniline was also studied. As a general result it appears that when benzyl-chloride acts upon amines at a high temperature, or at a lower temperature in the presence of zinc chloride, the hydrogen of the aromatic nucleus is attacked; and in cases where the amido-group contains any replaceable hydrogen, or other radicle, substitution likewise takes place in the group, with the formation of substituted amido-derivatives of diphenyl-methane.

"On Pentathionic Acid" (Part II.), by WATSON SMITH and T. TAKAMATSU. The authors reply at some length to the criticisms of Lewes, Spring, and Curtius, and give the results of some further investigations of the subject, on the effect of neutralising a solution of pentathionic acid in dilute alcohol with barium carbonate, and on the effect of solutions of alkalis on pentathionic acid solutions.

The Society then adjourned to April 6th (Anniversary Meeting, March 30th), when the following papers will be read:—"Observations on the Action of Acetylic Chloride on Fumaric Acid," by W. H. PERKIN; "Note on a Convenient Apparatus for the Liquefaction of Ammonia," by J. E. REYNOLDS; "Transformation of Urea into Cyanamide," by H. J. H. FENTON; "Some Arguments in favour of Ladenburg's Prismatic Formula of Benzene," by W. K. DUTT.

THE AMERICAN CHEMICAL SOCIETY.*

THE February meeting of the American Chemical Society was held on Friday evening, February 3rd.

Dr. Orazio Lugo was elected a regular member.

* Communicated by M. Benjamin, Ph.B., F.C.S.

The first paper of the evening was "On Crystallised Anhydrous Grape Sugar," by Dr. ARNO BEHR.

It was customary in the preparation of the anhydrous grape-sugar to crystallise it out from an alcoholic solution, particularly from that of methylic alcohol, but Dr. Behr was led to believe it possible that a simpler method could be devised. After some experimenting, he found that it could be obtained from the ordinary hydrated solution. A solution with 12 to 15 per cent of water gave the best results. In the description of its properties, Dr. Behr stated that when dried in a current of dry air the crystallised sugar would not retain more than two or three per cent moisture, its reaction is neutral, its melting-point is between 141° and 145° C. When tested by the polariscope it showed birotation. Dr. Behr then referred briefly to its economic uses, how by its cheapness it would be largely used by the confectioner, the druggist, and by those who manufacture wines. He also stated that as regards its sweetening qualities, instead of requiring twice as much or more to make it equal to cane sugar, he had found that one and two-thirds as much was sufficient.

Mr. NELSON H. DARTON followed with a short paper "On the Precipitation of Tannic Acid as Tannate of Copper." This paper was a supplementary description of Mr. Darton's method, already read before the Society. It consists in the precipitation of tannic acid by the ammonia sulphate of copper. The precipitate was tested for ammonia with negative results, and therefore it was contended by Mr. Darton that the precipitate was composed of copper tannate and not the double salt as has been elsewhere claimed.

The final paper of the evening was by Dr. E. WALLER, of the School of Mines, Chemist to the New York Board of Health. Its title was "On the Water Supply of New York City." The object of this paper was to contradict certain statements made by Prof. Leeds in his recent paper read before the Society and published in the CHEMICAL NEWS. Dr. Waller produced the analysis made by Dr. Booth in 1843, then by Dr. Chilton, running between the years 1843 and 1859. Dr. Chandler's results from analysis in 1869-72, and finally his own, which have been regularly reported since 1872. These latter were represented by means of curve lines on diagrams which showed exactly the amount of each constituent for any time during the past nine years. These we may condense and show by the following table:—

	PARTS IN 100,000.		
	Maximum.	Minimum.	Average.
Mineral matter	8.44	3.22	5.702
Org. and vol. matter	4.40	0.04	1.67
Total solids	11.07	4.80	7.38
Hardness	5.40	1.88	3.21
Oxygen by permanganate method	0.383	0.047	0.180

The results obtained by Professor Leeds in comparison with those showed from the above table were in several instances quite different. Thus, Professor Leeds finds the total solids to be higher than any result obtained by the New York Board of Health during the past fourteen years. In other determinations similar discrepancies were shown by Dr. Waller. The statement that the Croton water was contaminated by tanneries and other factories was objected to as incorrect, the tanning having long since ceased on account of the scarcity of trees. A statement from the Chief Engineer of the Water Department was read, in which he claimed that the water shed of the Croton River was the cleanest of any from which the supply of drinking water was obtained, either in this country or abroad. The population of the country through which the Croton flows does not exceed 20,000 inhabitants, or about one person to every ten acres. In comparison with other cities, the number of inhabitants to the square mile residing along the water shed of Croton was stated to be extremely small, thus:

	Population to the Square Mile.
London	270
Boston	229
Brooklyn	119
Schenectady { Drawing their supply from } Conoes { the Mohawk River }	103
West Troy	77
Albany	86
Poughkeepsie { Supplied from Hudson } River. {	65
Hudson	36
New York	
Rochester	

By arguments such as the above, Dr. Waller maintained that the conclusions reached by Professor Leeds were erroneous. In the discussion that followed certain of Dr. Waller's modes of analysis were criticised by Dr. Endemann, but his remarks were merely on a side issue, and had no bearing on the results.

NOTICES OF BOOKS.

Experimental Chemistry for Junior Students. By J. EMERSON REYNOLDS, M.D., F.R.S., &c. Part II.—Non-metals. London: Longmans and Co.

THE author begins this portion of his treatise with a series of experiments intended to show the properties of atmospheric air, at the same time remarking that air is not a chemical compound, but a mere mechanical mixture. He classes carbon dioxide, water, ammonia, and ozone as "impurities,"—a term of doubtful legitimacy in case of a mixture. In the succeeding chapter he passes on to experiments in illustration of the compounds of nitrogen. These experiments must be pronounced easy, simple, and well-chosen. After dealing with the halogens Dr. Reynolds passes on to fluorine, and here he describes a very interesting experiment, which we never remember having seen mentioned in an elementary treatise. He directs sheep's teeth, powdered, to be heated in a test-tube with concentrated oil of vitriol, when the tube will be found distinctly corroded by the hydrofluoric acid liberated from the enamel of the teeth. Silicon and carbon are next taken in hand, the hardness of water being introduced under the latter as due, in many cases, to dissolved carbonates. Then follow experiments on coal-gas and on the nature of flame. Sulphur, boron, and phosphorus complete the series of elements introduced. As an Appendix is given a systematic process of testing for the common acid radicles.

That the phenomena referred to in this little book are described correctly cannot of course be questioned, but it is almost, if not altogether, impossible to present the elementary facts of chemistry in any novel light.

A Systematic Handbook of Volumetric Analysis, or the Quantitative Estimation of Chemical Substances by Measure, applied to Liquids, Solids, and Gases. By FRANCIS SUTTON, F.C.S. Fourth Edition. London: J. and A. Churchill.

It is interesting to compare the present edition of Mr. Sutton's work with its original form in 1863. In bulk it has been more than doubled, owing to the many important additions which have been found necessary. In the book before us we find, e.g., instructions for the volumetric analysis of compounds of aluminium, cadmium, cerium, uranium, vanadium, cobalt, and nickel; of raw kainite; of fruit-juices; soaps; of phosphoric and silicic acids in natural waters, two constituents often ignored by analysts, though the presence of the former may often supply important evidence concerning animal pollution. The

volumetric analyses of gases is treated at considerable length, and with much care.

Among alkalimetric indicators the reader will find an account of the properties and advantages of Poissier's Orange 3, Tropæolines oo and ooo, Phenol-phthaleine, Eosine, and Coralline. The author gives the preference to the first of these bodies, as being unaffected by carbonic acid and sulphuretted hydrogen, and acting well with ammonia. The tropæolines have in the main similar properties, and are equally applicable without the aid of heat, but are somewhat less sensitive. Phenol-phthaleine is useless in presence of carbonic acid and ammonia, whilst coralline has no well-marked superiority over litmus.

Many of the methods recommended in the earlier editions have been greatly modified, or omitted in favour of processes more accurate and convenient. Thus under Indigo the method of Schlumberger is omitted, as also the permanganate process. In their stead we find the potassium ferricyanide process (Ullgren's), whilst the bi-chromate process—formerly known as Penny's—is now attributed to MacKinlay, and is described at greater length, particular attention being given to the difficult point, *i. e.*, the recognition of the end of the reaction.

The process given for the volumetric determination of soap is based upon Clark's universally-known method for finding the hardness of water.

As regards sulphuric acid Mr. Sutton strongly urges the claims of the volumetric as preferable to the gravimetric method. He endorses the opinion of Teschemacher and Smith "that the estimation of sulphur and sulphuric acid by the weight of barium sulphate obtained is, and can be, correct only by accident, and when the adherent impurity happens exactly to counterbalance the barium sulphate dissolved." (See CHEMICAL NEWS, xxiv., pp. 61 to 66).

The volumetric determination of phosphoric acid is discussed in detail. The author holds that two methods only are admissible—that by uranium, and Stolba's method, where the phosphoric acid is separated as ammonium-magnesium phosphate, with subsequent titration by means of standard acid. Among the ways of removing the phosphoric acid from mineral, and especially manurial, solutions, the preference is of course given to the molybdcic process, though the methods of Graham, Reynoso and Girard, Chancel and Joulie are described as useful under certain conditions. The lead-process (Mohr's) is omitted. Under this head Mr. Sutton makes some severe, but not unmerited, comments upon the so-called "high" and "low" analysts, and upon such as profess to work by secret methods. We may here ask whether it is not unprofessional to patent an analytical process—a case which has happened, we understand, more than once.

Turning to the analysis of chrome-iron we find, in addition to the modified process of O'Neill, the methods of Britton and Sell.

Under Copper we find the same processes as in the first edition, with the addition of that of Weil (by means of stannous chloride) and of Steinbeck's instructions for the technical examination of cupreous minerals. Carnelley's colorimetric process is recommended for slags and poor ores.

Manganese, in its various states, forms the subject of an extensive chapter. There are instructions for the volumetric analysis of ferro-manganese and spiegeleisen, steels, manganiferous slags, &c. For the technical examination of scruples of manganese-ores, as used for the manufacture of bleaching-powder, we find the processes of Fresenius and Bunsen, Pickering's method for Weldon mud, as also the oxalic acid and the iron methods. In case of commercial samples of the black oxide, a careful determination of moisture is recommended as necessary.

Mr. Sutton says no more than the exact truth when he declares that his work has become the standard text-book on the subject wherever the English language is spoken, and the present edition will, we doubt not, find increased favour in proportion to its greatly increased completeness and utility.

CORRESPONDENCE.

READING BURETTES.

SIR,—Mr. James H. McMahon recommends (CHEMICAL NEWS, vol. xlv., p. 109) his recently invented method of correct reading off of burettes; but allow me to state that this reflex method has already been mentioned in Mohr's "Titrimethode," p. 10, published in 1862.—I am, &c.,

DR. ALFRED WOLF.

Wakefield, March 15, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 10, March 6, 1882.

Normal Carbonic Acid of the Atmosphere.—M. Dumas.—The author whilst proposing further observations in different parts of the world with the view of determining the fluctuations of the atmospheric carbonic acid, remarks that the antagonistic action of plants and of animals is probably a less important factor than the emission of carbonic acid from volcanic fissures and craters, and its fixation in the form of calcium carbonate in the seas.

Experiments made with a Faure's Secondary Battery.—MM. Allard, Le Blanc, Joubert, Potier, and Tresca.—The authors find in their experiments that the use of the accumulator costs 0.40 of the work furnished by the dynamo-electric machine which had produced the current, or in other words, 0.40 of the electric work which would have been available without its intervention. It is but justice to add that in many cases this loss would be compensated by the convenience of having at hand and entirely at disposal an abundant source of electricity. The battery forms, moreover, a powerful regulator.

Double Decompositions of the Haloid Salts of Mercury by the Hydracids and by the Haloid Salts of Potassium.—M. Berthelot.—A series of thermo-chemical determinations, the results of which are expressed in tables.

A New Pump for the Compression of Gases.—M. Cailliet.—This memoir cannot be usefully reproduced without the accompanying illustration.

A Rapid Method for Determining the Density of Gases.—G. Chancel.—This paper requires the two accompanying illustrations.

Hydrodynamic Experiments: Direct Imitation by Liquid Currents of the Reciprocal Action of Electric Currents.—C. Decharme.—A continuation from the memoirs inserted in the *Comptes Rendus*, February 13 and 20, 1880. The author continues tracing out analogies between currents of water and electric currents.

The Retrogression Produced by the Electric Effluve in the Transformation of Oxygen into Ozone.—P. Hautefeuille and J. Chappuis.—The transformation of oxygen into ozone during the electrification of the gas is limited; there is established an equilibrium between the production of ozone by the effluve and its spontaneous destruction, which is always rapid at the temperature to which the passage of electricity raises gases. The quantity of heat coming from this exothermic transformation increases as the proportion of ozone, and is added to the quantity of heat due to the rain of fire, or to the effluve. We may then easily conceive that it will occasion a destruction rapid enough to limit the transformation of the

oxygen, or even provoke periodically a decrease in the proportion of ozone. The author's experiments prove that the conversion of ozone into oxygen is the consequence of the liberation of heat, which accompanies the spontaneous destruction of ozone when raised to the unknown temperature of the effluve.

Certain Phosphates Neutral to Litmus.—MM. E. Filhol and Senderens.

Lutorcine, an Isomer of Orcine.—G. Vogt and A. Henninger.—This compound is described in a sealed paper which the authors deposited in 1875, and which has now been opened at their request. Lutorcine is obtained on treating mono-bromated para-cresylol with potassa. It crystallises in very small colourless needles arranged in hemispheric masses. It melts at 104° to 105°, and dissolves easily in water, alcohol, and ether, but less readily in benzol and chloroform. It differs from orcine by its crystallisation, its melting-point, and its coloured reactions. In presence of alkalies, lutorcine, on exposure to the air takes a blood-red tint; acids turn this colour to a yellow, but alkalies restore it. Chloride of lime gives a very intense and stable blood-red; potassium permanganate colours it also a bright red. With ferric chloride it takes a deep dirty green, and gives a reddish brown precipitate which does not contain iron. If treated with ammonia in presence of air it is converted into lutorceine, which has a brownish yellow colour, and is turned by acids to a pure yellow. This lutorceine dyes yellow.

Soluble and Insoluble Modifications of the Ferment of Gastric Digestion.—A. Gautier.—The author, referring to M. Béchamp's memoir in the last number of the *Comptes Rendus*, on the "Gastric Microzymas and their Digestive Power," combats the view that the agents of digestion are organisms. He shows that the action of the corpuscles of the gastric juice is not hindered any more than that of pepsine by considerable doses of hydrocyanic acid (1-200th), which even in much smaller doses proves fatal to vibrios and all figured ferments.

Bulletin de la Société Chimique de Paris.

Tome 37, No. 1, January 5, 1882.

Formation of Benzhydryl-propionic Acid.—E. Burcker.—This compound is obtained by the action of succinic anhydride upon benzol in presence of aluminium chloride. It is a higher homologue of the phenyl-glycollic and phenyl-lactic acids.

Preparation of Triphenyl-methan.—C. Friedel and J. M. Crafts.—The authors propose as the best proportions 1000 parts benzene, 200 chloroform, and 200 parts aluminium chloride, the latter being added in four or five portions, to avoid a too violent reaction.

Synthetic Formation of Phenyl-propyl-aceton.—E. Burcker.—The author has formed this compound by causing butyryl chloride to act upon benzol in presence of aluminium chloride.

No. 2, January 20, 1882.

The Forms of Calcium Carbonate.—M. Schützenberger.—The author has observed that a solution of this salt in water containing much carbonic acid yields on boiling arragonite, whilst in presence of a small quantity of carbonic acid there are obtained hexagonal stars with a centre in the form of a sphere. Artificial calcium carbonate (arragonite) if heated to 200° to 300° gives, when raised to the boiling-point of sulphur, an escape of carbonic acid, which ceases in a few minutes.

Presence of Free Fluorine in the Fluorspar of Wölsendorf.—O. Loew.—The author proves that the odour of this mineral is due to free fluorine, furnished by the decomposition of a cerium perfluoride, analogous to manganese perchloride, and splitting up at low temperatures into a fluoride and free fluorine.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 13, No. 13.

On Trioxymaleic Acid.—S. Tanater.—Potassium maleate is oxidised by means of the gradual addition of dilute permanganate to the refrigerated solution.

Constitution of Isomeric Hydrocarbons.—Julius Thomsen.—The author is of opinion that the constitution of such bodies may be studied thermo-chemically.

Thermo-chemical Researches on Cyanogen and Hydrocyanic Acid.—Julius Thomsen.—The author pronounces the value for the formation heat of hydrocyanic acid, as determined in the moist way by M. Berthelot, perfectly useless.

On Citric Acid.—G. Andreoni.—The author is attempting the synthesis of citric acid by a process quite distinct from that of MM. Grimaux and Adam.

Behaviour of Starch with Glycerin.—K. Zulkowsky.—Starch is soluble in glycerin at about 130°, and if the mixture is heated to 190° the starch is found to have passed into the soluble modification more or less completely according to its origin. Potato-starch is converted most readily, then wheat-starch, whilst rice-starch is slowly and sparingly acted upon.

Synthesis of Meta-isopropyl-toluol.—A. Ziegler and W. Kelbe.—The cymol formed from isopropyl-iodide and toluol in presence of aluminium chloride, and the cymol of resin-oil, are meta-isopropyl toluol.

On Bromnitro-, Nitro-, and Amido-Camphor.—R. Schiff.—Not capable of useful abstraction.

Position of Bromine in Brom-camphor.—R. Schiff.—A brief hypothetical note.

Action of Zinc Chloride upon Brom-camphor.—R. Schiff.—By heating these bodies together to 150° to 160° the author obtained a hydrocarbon and a phenol, which are here described.

Nitro-derivatives of Mono- and Disulpho-diphenylic Acid.—S. Gabriel and A. K. Dambergis.—Not susceptible of abstraction.

On Camphoro-carbonic Acid.—J. Kachler and F. V. Spitzer.—This compound undergoes spontaneous decomposition below 100°. It can be crystallised from water, the temperature of which must not exceed 80°, and forms long colourless needles, which melt at 123° to 124°. If treated with metallic sodium in a solution of absolute ether, there is formed a brilliantly white, non-hygroscopic, sodium compound.

Production of Lauric, Myristic, Palmitic, and Stearic Aldehydes.—E. Krafft.—This memoir does not admit of useful abridgment.

On Amarine.—A. Claus and K. Elbs.—The authors have obtained and studied amarin-methyl-iodide, amarin-benzyl-chloride, methyl-amarine, and benzyl-amarine.

A New Synthesis of Sulphydantoine.—R. Andreasch.—The author has obtained this compound by the mutual action of cyanamide and thio-glycolic acid. In this manner sulphydantoines in general may be obtained from the thio-acids.

On Carbamid-sulphon-acetic Acid.—By R. Andreasch.—This compound is a derivative of sulphydantoine, obtained by treating the latter in crystals with hydrochloric acid and finely powdered potassium chlorate.

On Chlorinised Quinons.—S. Levy and G. Schultz.—The authors have found it possible to proceed from monochloro-quinon in a regular series to chloranil.

Atomic Weight of Ytterbium, and on certain of its Salts.—L. F. Nilson.—The author gives 173.01 as the atomic weight of ytterbium. Ytterbia is decidedly a sesquioxide, Yb₂O₃.

Atomic Weight and certain Characteristic Compounds of Scandium.—L. F. Nilson.—The atomic weight of this element is 44.03. Its earth, scandia, is

without doubt Sc_2O_3 . It is especially interesting that the atomic weight deduced from the author's determinations gives for scandium exactly the same figure as Mendeleeff has assigned to the predicted element "ekabor," which is doubtless identical with scandium. The molecular heat and volume of scandia characterise this earth as an intermediate member between glucina and yttria.

Atomic Weight and Essential Properties of Glucina.—L. F. Nilson and Otto Pettersson.—Assuming glucina to be a sesquioxide, the atomic weight of glucinum is 13.65. Glucina claims a place among the earths, R_2O_3 , on account of its molecular heat and molecular volume. The authors, in conclusion, reply to the criticisms of Mr. T. Carnelley, who makes glucinum a bivalent element.

Molecular Heats and Volumes of the Rare Earths and their Sulphates.—L. F. Nilson and O. Pettersson.—The authors give in a table the formulæ, molecular weights, specific weights, specific heats, molecular heats, and molecular volumes of glucina, alumina, scandia, gallium oxide, yttria, indium oxide, erbia, ytterbia, lanthanum oxide, didymium oxide, zirconia, cerium oxide, and thoria. The chromic oxide, ferric oxide, yttria, didymium oxide, erbia, ytterbia, and cerium oxide are magnetic, whilst glucina, alumina, scandia, indium and lanthanum oxide, zirconia, and thoria are diamagnetic.

Chemical Composition of certain Hydrated Oxides.—J. M. van Bemmelen.—The author gives a tabular view of the molecules of water associated with 1 molecule of water in silica, metastannic acid, stannic acid, hydrous manganese dioxide, and black manganese dioxide. He concludes that the water of hydration is in general a variable accidental magnitude, depending on certain temperatures, degrees of atmospheric moisture, and modifications of the oxide.

Non-existence of Potassium Copper Chromate, and on Two New Basic Copper Chromates.—Max Rosenfeld.—The two basic chromates are respectively yellow, $2\text{CrO}_3 \cdot 7\text{CuO} + 5\text{H}_2\text{O}$; and brown, $\text{CrO}_3 \cdot 7\text{CuO} + 5\text{H}_2\text{O}$.

Lecture Experiments.—M. Rosenfeld.—An illustrated paper.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 1, 1882.

A Curious Chemical Anomaly.—Already inserted at length.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. x., Part 12.

The Results of the Principal Experiments of Lawes and Gilbert.—Dr. Paul Behrend.—An abstract from the publications of the Royal Agricultural Society.

Behaviour of Different Phosphates in the Soil.—Dr. Hoffmeister.—The result of the experiments is that by far the greater part of the phosphoric acid originally soluble in ammonium citrate remained in this, or in a very similar state at the end of the experiments. The fear that a part of the soluble phosphoric acid of the superphosphate might quickly be converted into the insoluble tribasic state proved unfounded.

Prof. Heeren's New Milk-Test.—This newly-invented instrument, the "pioskope," consists of a disc of black vulcanised caoutchouc, having in its middle a very flat, circular depression. A few drops of the milk in question, well mixed, are placed in the hollow and covered with the second part of the apparatus, a plate of glass painted with six shades of colour radiating out from a small uncoloured circular spot in the middle. The colours range from white, grey, to deep bluish grey. The layer of milk is seen through the uncoloured spot in the centre, and its colour can thus be compared with the radiating colours, and its quality is judged according to the colour with which it coincides. Thus the whitest colour stands for cream, the next for very rich milk; then follow in succession—normal, inferior, poor, and very poor.

MEETINGS FOR THE WEEK.

MONDAY, 27th.—Geographical, 8.30.
— Medical, 8.30.
— Society of Arts, 8. "Hydraulic Machinery," by Prof. John Perry.
TUESDAY, 28th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Royal Institution, 3. "The Mechanism of the Senses," by Prof. J. G. M'Kendrick.
WEDNESDAY, 29th.—Society of Arts, 8. "A New Antiseptic Compound, and its Application to the Preservation of Food," by Prof. Barff, M.A.
THURSDAY, 30th.—Royal, 4.30.
— Royal Institution, 3. "Resemblances of Sound, Light, and Heat," by Professor Tyndall.
— Chemical, 8. (Anniversary).
FRIDAY, 31st.—Royal Institution, 8. "Electric Discharge in a Magnetic Field," by Mr. W. Spottiswoode, at 9.
SATURDAY, April 1st.—Royal Institution, 3. "Volcanoes," by Prof. H. G. Seeley.

ERRATA.—In Dr. Debus's Lecture on "The Chemical Theory of Gunpowder" (p. 91).—Col. 1, line 26 from top, for "ammonia and hydrogen," read "ammonia, hydrogen, and water." Line 15 from bottom, for "of the volume," read "by the volume." P. 92, col. 1, line 34 from top, for "the sulphides," read "the higher sulphides." In same paragraph, for "quantity of potassic sulphide," read "quantities of potassic sulphate." P. 93, col. 1, line 6 from bottom, for "+aCO," read "+aCO."

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Titanic Acid		5'80	6'20
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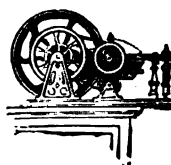
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THE CHEMICAL NEWS.

Vol. XLV. No. 1166.

1 APR 82

ON THE SULPHATES OF ALUMINIUM.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon.,
Assistant Master at Highgate School, and Chemical Lecturer
at Bedford College.

(Continued from p. 115.)

V. Solution of Aluminium Hydrate and Basic Sulphate
by the Normal Sulphate.

SOME of the normal sulphate was treated with excess of ammonia, and the precipitate, after being washed, was dissolved in hydrochloric acid, and re-precipitated in the same way; after it had been well washed it was found to contain no trace of sulphate or chloride. Small quantities of the moist hydrate thus obtained were gradually added to boiling solutions of the normal sulphate of various strengths until a further addition caused a cloudiness which would not disappear, even when the ebullition was continued for one to four hours longer. The strength of the normal solution taken varied between that of one which was nearly saturated at the boiling temperature, and which entirely solidified on cooling, and a 1 per cent solution. The water expelled during the ebullition was replaced. All the basic solutions thus obtained remained quite clear on standing for an indefinite time in the cold; their composition is given in the third column of Table II., and the numbers here show that the amount of alumina thus dissolved does not render the solution much more basic than a solution of the normal sulphate is (the normal sulphate containing 29.848 per cent of Al_2O_3), and that the basicity of the solution obtained increases regularly with the strength of the solution taken. The time required for the saturation of the normal sulphate varied from two hours in the case of Expt. 44 to about twenty-six hours in that of Expt. 47. All these solutions on dilution with cold water became more or less cloudy. In order to make sure that none of the sulphuric acid was driven off during the ebullition, Expt. 45 was repeated without the addition of any alumina; after being boiled for two and a half hours the sulphate was found to contain 29.918 per cent of Al_2O_3 , showing that none of the acid had been lost. Strongly ignited alumina was found to dissolve to a considerable extent in a strong boiling solution of the normal sulphate; it did not, however, dissolve so easily as the hydrated substance did, but no determination of the amount taken into solution was made.

On treating cold solutions of the normal sulphate with the moist hydrate, this latter was found to dissolve more or less quickly as the solution taken was stronger or weaker; but even in the case of the strongest solution (containing 16 per cent $\text{Al}_2\text{O}_3 \cdot 3\text{SO}_3$), the action is extremely slow, not being complete at the end of two months.

In order to see whether a basic sulphate would dissolve in the normal sulphate to a larger extent than the hydrate does, a sulphate containing about 68 per cent of alumina (obtained by the dilution of a strong basic solution) was taken and added gradually to a boiling 16 per cent solu-

tion of the normal salt. After the liquid had become saturated, it was found to contain a sulphate with 52.984 per cent of alumina, and was therefore considerably more basic than any solution obtained by the use of the hydrate. This percentage, however, corresponds to that of no definite compound, and it was proved that in this case also the basicity of the solution depended on its concentration, for even a very small addition of water to it while boiling caused a precipitate to separate, and the amount of this precipitate was increased by further dilution. The solution obtained in this experiment was very strong, being nearly saturated at the boiling temperature, and containing 0.5 grm. of the basic sulphate per c.c. Although it did not solidify at once on cooling, on standing, however, for a few days it did so without becoming cloudy, and it was apparently incapable of taking up any more of the basic sulphate on digestion with it in the cold. It could be diluted with a very small amount of cold water without decomposition (at least, without immediate decomposition), but a further dilution produced an abundant flocculent precipitate.

Here, again, in these experiments it is evident that the composition of the product varies with the physical conditions under which it is obtained, and affords no evidence whatever of the existence of any definite basic compound; nor do these experiments support Maus's statement (*loc. sup. cit.*), that by saturating a solution of the normal sulphate with aluminium hydrate or basic sulphate, a solution of $\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3$ (containing 38.954 per cent of Al_2O_3) is obtained. Marguerite's statement on the subject will be discussed in the next paragraph.

VI. Ignition of Ammonium Alum.

When ammonium alum is heated, it first loses its water and then its ammonium sulphate, leaving a residue of anhydrous aluminium sulphate, which is very difficultly soluble in cold water, but easily soluble in boiling water. When this anhydrous aluminium sulphate is further ignited, it gradually loses its acid, and finally leaves a residue of pure alumina; this action, however, can only be completed by operating on very small quantities, and using a high temperature. On igniting a weighed portion of the alum in this manner for many hours and weighing it at intervals, the loss of acid was found to proceed constantly, but at a decreasing rate. After the ignition had been continued for some time, the product was still found to dissolve completely in boiling water, and this was found to be the case until it contained about 33 per cent of alumina; after this point, however, an insoluble portion made its appearance, and continued to increase in amount as the ignition was prolonged; in fact the whole action appears to be nothing but a continuous decomposition of aluminium sulphate into a more and more basic substance, and finally into alumina, this basic product dissolving entirely in the boiling solution of the still unattacked normal sulphate, so long as the amount of it present is not too great.

The above experiments were performed as a repetition of some work of Marguerite's (*Comptes Rendus*, xc., 1354), which consisted of partially decomposing the aluminium sulphate obtained by the ignition of ammonium alum, and dissolving the product in boiling water, a solution being thus obtained from which, on evaporation, rhombohedra, either simple or terminated in four-sided pyramids, crystallised out before the normal salt did, and which consisted of $\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3$. Similar crystals, he states, were obtained in small quantities by dissolving aluminium hydrate in the normal sulphate; also by treating the normal sulphate with zinc. They dissolved easily in cold or hot water; to the extent of 45 per cent in the former. The only analytical numbers quoted are the following:—

Al_2O_3	2SO_3	$12\text{H}_2\text{O}$
21.2	33.84	44.9 per cent.

In some preliminary repetitions of these experiments, the author of the present paper obtained in each case

TABLE II.

Aluminium Sulphate Solution boiled with Aluminium Hydrate.

	Strength of Normal Solution taken.	Composition of the Basic Sulphate in the Solution obtained.
44.	40 to 50 per cent	34.83 per cent Al_2O_3
45.	17 "	34.647 " "
46.	2 "	34.316 " "
47.	1 "	33.532 " "

small crops of crystals, which, though scarcely rhombohedra, might possibly at first sight have been mistaken for rhombohedra terminated in four sided pyramids. They also contained nearly exactly the same percentage of sulphur trioxide as those obtained by Marguerite. The alumina percentage, however, was very different, and it was soon discovered that these crystals were in reality nothing but potassium alum, which was found to be present as an impurity in every specimen of ammonium alum and of aluminium sulphate which could be procured in commerce; and although it is difficult to see how any chemists could have made such a mistake, still it is a remarkable fact that if the potassium oxide be calculated as alumina, the analytical numbers yielded by alum would be almost identical with those quoted by Marguerite. Thus in alum—

$\text{Al}_2\text{O}_3 + \text{K}_2\text{O}$	4SO_3	$24\text{H}_2\text{O}$
20.789	33.716	45.495 per cent.

At any rate it may be stated that no confirmation whatever could be obtained of the existence of Marguerite's "new" sulphate, $\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3$, which, however, had been described by Maus fifty-two years previously as an insoluble powder (*vide supra*), and that no crystals of any kind except those of the normal sulphate ever separated out on the evaporation of a basic solution, however obtained.

VII. Aluminium Sulphate Treated with Zinc.

Debray (*Bull. Soc. Chim.* (II.), vii., 9), by boiling some aluminium sulphate with zinc in a platinum capsule, obtained a precipitate which on analysis was found to contain 68.843 per cent of alumina (neglecting the water present), and which he therefore concluded to consist of $5\text{Al}_2\text{O}_3 \cdot 3\text{SO}_3$ (which requires 68.023 per cent Al_2O_3).

In order to make a more exhaustive examination of this action, solutions of the normal sulphate of various strengths were heated with distilled zinc in a steam-bath at 100°C ., condensing tubes being fitted into the flasks containing the solutions. With strong solutions hydrogen was given off at first with great energy, and after from two-and-a-half to forty hours the action became very slow indeed, and a cloudiness appeared in the solution: this cloudiness gradually increased till it formed a precipitate sufficient for analysis. The composition of the precipitate thus obtained in various cases is given in the first part of Table III. The figures in the second and third columns show that the deposition of the basic sulphate takes place more quickly as the solution is more concentrated: the numbers in the third column are, however, only approximations. The figures in the last column show that the precipitate formed is more basic as the solution taken is weaker.

TABLE III.

Aluminium Sulphate Solution Digested in Zinc at 100°C .

	Strength of the Solution.	Duration of the Heating.	Al_2O_3 precipitated, that in the Solution taken being 100.	Percentage of Al_2O_3 in the Anhydrous ppt.
	Per cent.			
48.	3.6	15 hours	8.0	63.05
49.	7.2	28 "	14.0	68.36
50.	3.6	26 "	5.3	68.881
51.	1.71	92 "	8.0	69.50
49.	7.2	28 "	14.0	68.36
52.	7.2	From the 28th to the 41st hr.	8.7	68.9
53.	7.2	From the 90th to the 139th hr.	5.8	70.058
50.	3.6	26 hours	5.3	68.881
54.	3.6	From the 26th to the 62nd hr.	9.0	69.023
51.	1.71	92 hours	8.0	69.50
55.	1.71	From the 92nd to the 147th hr.	8.6	69.733

The last experiments given in the table were made in order to ascertain whether the precipitate deposited by any particular solution remained constant in composition during its deposition or not. Solutions of three different strengths were examined, and they all showed that without exception the precipitate became more basic as the action proceeded. The rate of its formation also gradually diminishes, as might have been expected, although to show this we must in the case of the first portion subtract from the numbers given in column 2 the time during which the zinc was dissolving and no basic sulphate was being deposited.

Here we see that although the precipitate obtained in this action is in most instances not very dissimilar from that obtained by Debray, still its composition is not constant, but varies with a variation in the physical conditions of the experiment. In fact no definite chemical compound can be regarded as being formed in this action.

In the above experiments a deposit was invariably formed on the glass vessel employed similar to the main precipitate, except that it dissolved only with great difficulty even in strong boiling hydrochloric acid (this being the only basic sulphate met with which was not easily soluble in the weak cold acid). It was not included in the portions taken for analysis as given in Table III., but a separate examination of that deposited in experiments 49 and 53 gave the percentages of alumina as being 56.971 in the first case and 60.905 in the other, showing that this less soluble deposit was not so basic as the main precipitates, and that like this latter it increased in basicity as the action proceeded.

When a platinum vessel was substituted for the glass flask used in the above experiments, the action appeared to be the same in kind, but proceeded with greater rapidity owing to the voltaic action of the two metals in contact with each other.

Debray (*loc. sup. cit.*), on leaving a solution of aluminium sulphate with zinc in a platinum dish at ordinary temperatures for eight days, obtained a jelly, which, when washed and dried over sulphuric acid, was found to contain 63.55 per cent of alumina (without including 49 per cent of water present).

On making a few experiments similar to that of Debray's, it was found that with saturated solutions, and solutions containing more than 18 per cent of the normal sulphate, the action which took place at first was soon stopped, owing in all probability to the insolubility of the zinc sulphate formed in the strong solutions; but that with a 17 per cent solution the whole became converted into a firm transparent jelly at the end of four or five days. On attempting to wash the jelly with solutions of the normal sulphate of decreasing densities it was found to dissolve easily and completely, while treatment with pure water made it opaque and entirely decomposed it, thus rendering it impossible to determine its composition. Debray's analysis must therefore refer not to this jelly, but to its decomposition product with water, more or less contaminated perhaps with some of the undecomposed jelly itself. On repeating these experiments with more dilute solutions, it was found that the jelly became more and more thin and cloudy, until with a 3.3 per cent solution no jelly at all was formed, and the sole product of the action was a white flocculent precipitate. The analysis of this precipitate, together with those of other precipitates, obtained in similar experiments with still more dilute solutions, is given in Table IV. The first four experiments in this table, with one exception, indicate a slight increase in the basicity of the precipitate, as the solution taken is stronger. The increase, however, is not greater than what might be put down to experimental error. The last three experiments were performed when the temperature of the laboratory was some degrees higher than in the other cases, and the precipitates here are less basic than the others, the first two of these showing a variation in the same direction as Nos. 56 to 58.

TABLE IV.

Aluminium Sulphate Digested with Zinc in the Cold.

	Strength of the Solution.	Al ₂ O ₃ precipitated, that in the sol. taken being 100.	Al ₂ O ₃ in the Anhydra. ppt.
56.	1.10 per cent	37.4	66.149
57.	1.64 "	31.9	66.169
58.	1.95 "	42.2	66.339
59.	3.3 "	33.6	66.215
60.	0.66 "	33.4	65.181
61.	0.78 "	48.2	65.979
62.	2.47 "	32.0	64.625

The close concordance of the first four numbers would suggest that the precipitate might be a definite chemical compound were it not that these numbers do not correspond to any particular formula, the one which they most nearly satisfy being $3\text{Al}_2\text{O}_3, 2\text{SO}_3$, which requires 65.687 per cent of alumina. It might even here be possible that they did consist of this basic sulphate, since their being rather more basic than the formula requires might be due to the decomposing action of the wash-water, but that in the cases of Nos. 60 and 62 we have some which are less basic than $3\text{Al}_2\text{O}_3, 2\text{SO}_3$, even in spite of this decomposing action. In addition to this we have the fact that the composition of the product evidently depends to a considerable extent on the temperature at which the action takes place. On the whole, it would seem to be extremely rash to assume that these precipitates are constant in composition, or that they consist of a definite chemical compound.

(To be continued.)

THE "VIDANGEUSE AUTOMATIQUE."

This apparatus is described as a closet hermetically closed, completely inodorous, and emptying itself incessantly. The Abbé Moigno in describing the sewage difficulty declares that, prior to this new invention, due to M. Louis Mouras, not a single effective step had been taken towards the solution of the problem. He declares that the Vidangeuse is hermetically closed by the safest of closings, the hydraulic joint, so that its contents are cut off from all contact with the ambient air, whence it is inodorous and all infection is rendered impossible. Further, by a "mysterious operation, which reveals a principle entirely novel," the apparatus transforms all that it receives, liquid and solid excreta, in a very short time and "without any addition of chemical ingredients" into a homogeneous liquid, scarcely turbid, which holds everything in suspension in the state of filaments scarcely visible, without depositing anything, either on the sides of the soil-pipe or at the bottom of the sewer. It empties itself automatically and incessantly; that is, each new volume of excreta introduced by the fall-pipe causes the discharge of an equal volume of the former contents elaborated and fluidified. The liquid as it issues out, deprived of none of the organic or inorganic elements of the excreta, may be received at once in a butt to serve for watering the garden, or it may flow into the sewer. The describer states that any existing closet can be arranged in accordance with the new system by merely adding a fall-pipe dipping with its lower end into the liquid in the "vidangeuse" and a discharge pipe which plunges with its bent upper end into the same liquid whilst the lower end is connected with the sewer.—*Les Mondes*.

(As the "vidangeuse" is protected by a patent a more complete description will doubtless follow).

Essence of Licari Kanali.—H. Morin.—The author has isolated from this product a hydrocarbon, $\text{C}_{20}\text{H}_{16}$, to which he gives the name licarene.—*Comptes Rendus*.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, March 25th, 1882.

Prof. CLIFTON, President, in the Chair.

New members—Mr. M. J. Jackson, B.A.; Mr. Nasarus Fletcher, British Museum.

Mr. SHELLFORD BIDWELL read a paper on the "*Electric Resistance of a Mixture of Sulphur and Carbon*." These experiments were begun in December, 1880, to ascertain if the mixture in question was sensitive to light like selenium. Sulphur was melted and mixed with powdered plumbago, the best proportions being 20 parts by weight of the sulphur to 9 parts of the plumbago. The mixture was poured into moulds and quickly cooled, yielding plates and sticks. When exposed to the light of a gas flame, an increase in resistance was noticed, and was proved to be due to the heat of the flame, not the light, by experimenting with different sources of light and coloured screens of glass. As both carbon and sulphur decrease in resistance under heating, this opposite effect of the mixture is anomalous, and Mr. Bidwell explains it by supposing that the mixture is mechanical, and that heat expanding the size of the insulating sulphur crystals separates the conducting carbon particles further apart, and increases the resistance of the mass. Cells of this compound were made like selenium cells by spreading it between the parallel turns of two fine platinum wires wound round a mica plate, and the rise of resistance for temperature carefully measured. At 14°C . the resistance was 9100 ohms, at 55°C . it was 5700 ohms, and the rise was in greater ratio than the rise of temperature. Mr. Bidwell also found that these cells would transmit speech when connected in the circuit of a battery and a Bell telephone; they also acted as a thermoscope, when employed after the manner of a thermopile. Mixtures of shellac and graphite, of paraffin and graphite, &c., were also tried with like results.

In reply to Prof. Macleod, Mr. BIDWELL said the resistance of the cells decreased soon after being made. Mr. Bidwell also stated that acting on a suggestion of Dr. Hopkinson, he had found that the resistance diminished under a more powerful current. This material would not answer for resistance boxes.

Mr. C. V. BOYS read a paper on a "*New Method of finding the Index of Refraction of Lenses*," based on the general principle employed by Foucault of causing the ray of light to return on the same path.

Prof. CLIFTON stated that a similar method was now employed by him at Oxford, and was useful for small lenses.

Prof. FITZGERALD, of Dublin, showed mathematically that it was impossible for a small charge of static electricity carried along by the earth to move a magnet in its neighbourhood.

Prof. AYRTON questioned this conclusion, and exhibited an apparatus intended to test the point experimentally.

The meeting was then adjourned till April 22.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, February 23, 1882.

Mr. B. S. PROCTOR in the Chair.

The minutes of last meeting were read and confirmed.

Messrs. J. R. Young, A. J. Smith, C. E. Stuart, B.Sc., and Dr. Rudolph Measel, were elected members of the Society.

The following papers were read:—

"On the Estimation of Arsenic in Copper," by JOHN PATTINSON, F.I.C., F.C.S. However delicate as a qualitative test for the presence of small quantities of arsenic in copper Messrs. Abel and Field's method, described in the *Quarterly Journal of the Chemical Society* for 1862, may be, I have found that it gives very uncertain and untrustworthy results when used as a quantitative method for the determination of this substance. Messrs. Abel and Field's method consists in adding a small quantity of nitrate of lead to the nitric acid solution of about 200 grains of the copper to be tested, and then excess of ammonia and carbonate of ammonia. The lead precipitate thus formed, which is supposed to contain all the arsenic contained in the copper, is then separated by filtration and washed, and the arsenic it contains dissolved by digesting the precipitate with solution of oxalic acid, ultimately obtaining the arsenic as ammonio-magnesium arsenate, with or without previous precipitation as sulphide. When carefully following all the instructions given in the above named paper, this method, when applied to a solution of copper known to contain 0.05 per cent of arsenic, only indicated 0.006 per cent of arsenic.

In attempting to discover a method which would give better results than this method, I have found that if a solution of copper in nitric acid is carefully neutralised with solution of caustic soda, and then a slight excess of the soda solution added, all the arsenic the copper contains is entirely precipitated as arsenate of copper before hydrated cupric oxide is precipitated; and, moreover, that hydrated cupric oxide precipitates arsenate of copper from solutions of copper so neutralised. On this reaction is based the process of estimating small quantities of arsenic in commercial copper which I have to describe.

From 100 to 400 grains of the copper to be examined, the amount varying with the quantity of arsenic supposed to be present, are dissolved in nitric acid. Solution of caustic soda is then carefully added to the cold or slightly warm solution until a slight but permanent finely divided precipitate is formed. A quantity of very dilute caustic soda, containing soda equal to twice the weight of arsenic supposed to be present, is now added, and the mixture well stirred every five minutes during half an hour to ensure the precipitation of the whole of the arsenate of copper. Care must be taken to use very dilute solution of soda when the free acid is nearly neutralised, and for the final precipitation, otherwise undesirable clots of hydrated cupric oxide will be formed. The precipitate is then collected on a filter and washed once or twice with cold water. The filtration is hastened if the solution with its precipitate is boiled after the soda has been added, but in this case it must be again cooled and allowed to stand for about an hour before being filtered, as the precipitate appears to be slightly soluble in a heated solution.

When examining unknown qualities of copper containing much arsenic, should any doubt exist that an insufficient amount of soda has been added to precipitate the whole of the arsenic, a second amount of soda should be added to the filtrate after the first precipitate has been separated, and the precipitate thus formed collected on a filter, dissolved in a little hydrochloric acid, and ammonia and magnesia mixture added and well stirred. The formation of a precipitate of ammonio-magnesium arsenate indicates the presence of arsenic. This precipitate should be collected and weighed. If no ammonio-magnesium arsenate precipitate is formed, the whole of the arsenic is in the precipitate formed by the first addition of soda.

Ammonia and its salts must not be added to the solution of copper from which the arsenic is to be thus separated, as I find they interfere with the complete precipitation of the arsenic.

The after-treatment of the precipitate formed by the addition of soda, and which contains the whole of the arsenic, depends on the presence or absence of other impurities in the copper.

I.—If, on dissolving the precipitate in hydrochloric acid and adding excess of ammonia, it is found that no insoluble matter remains in the solution, the arsenic acid may be at once precipitated as ammonio-magnesium arsenate by the addition of magnesia mixture (chloride of magnesium, chloride of ammonium, and ammonia). In the absence of phosphorus the ammonio-magnesium precipitate indicates arsenic only, but if phosphorus be present, the latter precipitate, after being weighed, should be dissolved in hydrochloric acid, and arsenic precipitated as tersulphide by sulphuretted hydrogen. The phosphoric acid in the filtrate is then again precipitated as ammonio-magnesium phosphate, the precipitate weighed and deducted from the weight of the first ammonio-magnesium precipitate.

Should phosphorus be present in the copper, the arsenic may also be separated from it by precipitating the arsenic as tersulphide before the formation of the ammonio-magnesium precipitate as described further on.

A sample of copper known to contain no arsenic or phosphorus, but to the solution of which arsenic acid equal to 0.5 grain of arsenic had been added, was tested by what may be termed the direct method described above, and an amount of ammonio-magnesium arsenate was obtained representing 0.5 grain of arsenic.

II.—Should the addition of ammonia to the solution in hydrochloric acid of the precipitate formed by the addition of soda to the copper solution give a precipitate, then the solution, if warm, should be cooled, and sulphide of ammonium added in excess, and the mixture allowed to stand for a few minutes in the cold. The insoluble sulphides are then separated by filtration and the arsenic acid is precipitated in the filtrate by magnesia mixture. Care must be taken that the solution is not warmed after the addition of sulphide of ammonium, otherwise the arsenic acid would be more or less reduced, and no precipitate of ammonio-magnesium arsenate may be formed.

Here, again, should phosphorus have been present in the copper it will also be obtained in the ammonio-magnesium precipitate and should be afterwards separated as before-described.

The results obtained by treating copper containing mixtures of various impurities and with known quantities of arsenic by this method were very satisfactory. A mixture of 100 grains of pure copper and 0.25 grain each of antimony, lead, bismuth, tin, and iron, to which 1.0 grain of arsenic was also added, yielded ammonio-magnesium arsenate equal to 0.98 grain of arsenic. Other analyses with various quantities of arsenic gave equally good results, and occasionally exactly the same amount of arsenic was found as was added to the mixture of metals.

When the copper to be tested contains iron and other impurities in some quantity, and when it is uncertain whether or not phosphorus is also present, the best way to proceed to separate the arsenic from the other substances carried down with the precipitate formed by the addition of caustic soda is probably as follows:—The last-named precipitate is dissolved in a little hydrochloric acid (any portion insoluble in this menstruum being allowed to remain in suspension in the liquid), ammonia and sulphide of ammonium in excess added, and the mixture kept at a temperature a little below boiling for about an hour. The precipitate of sulphides is then separated by filtration and the filtrate is acidified with hydrochloric acid. The arsenic, which has been reduced from arsenic acid to arsenious acid by the digestion with hot sulphide of ammonium, is readily precipitated as tersulphide, together with any antimony or tin the solution may have contained. These sulphides are then collected on a filter and washed and afterwards dissolved in fuming nitric acid. The arsenic acid is then precipitated by magnesia mixture after addition of excess of ammonia, and obtained as

ammonio-magnesium arsenate from which the percentage of arsenic is calculated.

Analyses made by the method last described have given very good results. Amongst several analyses made by this method may be mentioned the following:—Two mixtures of 100 grains of copper and 0.25 grain each of antimony, lead, bismuth, tin, and iron, to which 0.5 grain and 0.1 grain of arsenic respectively had been added, yielded 0.48 grain and 0.10 grain of arsenic respectively.

My thanks are due to my assistant, Mr. H. A. Kay, who has made most of the required analyses, and who has otherwise given much valuable help in carrying out this investigation.

"Contributions to the History of the Oxides of Manganese." By J. T. DUNN, M.Sc. Wishing to determine sulphurous acid dissolved in oil of vitriol, and casting about for a method which would not involve the use of such large bulks of air-free water as are necessary for accuracy in titrating with iodine, I tried, amongst other things, solution of permanganate of potassium. I proposed to sink the measured quantity of SO_2 solution under excess of standard permanganate solution, and to determine the amount of oxygen used up by excess of standard ferrous sulphate solution and back titration with permanganate. Of course, on adding the SO_2 to excess of permanganate, a quantity of brown hydrated oxide of manganese is precipitated, but addition of acidified ferrous sulphate, as is well known, easily reduces and dissolves this oxide.

It had long been well known that the precipitates produced by the action of reducing agents on excess of permanganate, as well as those formed by acting with alkalis and oxidising agents on manganous salts, have not, as a rule, the composition of manganese dioxide, but contain a percentage of oxygen falling short more or less of that required for the formula MnO_2 . Mr. Francis Jones states (*Jour. Chem. Soc.*, 1878, page 95) that he has observed an evolution of oxygen gas in all cases of the action of reducing agents on permanganate which he has examined, although he gives us no figures, nor any guide whatever as to the amount of gas which he has so noticed. So far as I am aware, no other author who has experimented with oxides of manganese makes any mention of oxygen being given off under these circumstances; but a possible connection between the evolution of oxygen and the deficiency in oxygen below the formula MnO_2 , exhibited by the precipitated oxides, at once suggests itself.

In my work with sulphurous acid, since it was necessary, in order to insure the complete diffusion of the saturated acid out of the narrow-necked little bottle in which it was weighed, to permit the permanganate solution under which it was sunk to stand over night, it is evident that any such evolution of oxygen as that mentioned by Jones, even if it took place very slowly, would have rendered the determinations useless. I endeavoured, therefore, to repeat some of Mr. Jones's experiments under determinate conditions, to ascertain whether, under these conditions, evolution of oxygen did take place, and, if so, to what extent. I afterwards, for other reasons, abandoned the use of permanganate in favour of bichromate; but the results of the few experiments which I made are perhaps worth while putting on record.

A small flask was taken, fitted with a two-holed cork, through which passed a gas-delivery tube and the tube of a stoppered funnel, the latter reaching to the bottom of the flask. Flask and delivery tube were completely filled with a solution of about 15 grms. of manganous sulphate (the same sulphate was used in all the experiments, and contained 11.32 per cent of water), and a solution of 0.63 gm. of permanganate, in a small quantity of water, was added through the funnel tube without admitting any air, the delivery tube of the flask dipping under water, and having a graduated tube filled with water inverted over it.

Immediately on the introduction of the permanganate a brown flocculent precipitate formed, but, after half an hour, there was no evolution of gas. The fluid in the

flask was now boiled, and yielded, after three-quarters of an hour, about 5 c.c. of gas, the precipitate at the same time becoming quite black. This gas was certainly not pure oxygen, and as an equal bulk of the distilled water used in making the solutions yielded, on boiling for the same length of time, about the same quantity of gas, there seems no reasonable doubt that in both cases the gas was air dissolved in the water, or which had diffused into the apparatus.

The experiment was next repeated, the flask this time being filled with a solution of about 5 grms. of permanganate, and 1.02 grms. of the manganous sulphate was dissolved in water, and run into it. The same brown precipitate was observed, but again no gas was given off in the cold. On boiling a slow evolution of gas took place, which ceased after about an hour, during which time about 200 c.c. was collected. A lighted match showed that the gas contained a large quantity of oxygen, and absorption of a sample by phosphorus showed that it was practically pure.

A blank experiment, made for precaution's sake, in which the same quantity of permanganate solution was boiled for an hour, without addition of manganous sulphate, and in which only 7 c.c. of gas was given off, showed that the gas in the last experiment did not come from the simple breaking up of the permanganate by heat.

The experiment was repeated with the same quantities of the materials, and they were left together in the cold for five days. No gas was collected in the measuring tube, but a few minute bubbles appeared hanging on to the precipitate.

It seems, then, that when solutions of permanganate and manganous sulphate are mixed, no evolution (practically) of gas takes place in the cold, and that, on heating, oxygen is evolved when the permanganate is in excess, but not when the manganous salt is in large excess. I next tried to ascertain whether the action was a determinate one, or whether, as seemed possible, it was an example of so-called "catalytic" action—whether the precipitated oxide acted towards the excess of permanganate in the way that cobaltic hydrate does towards bleaching-powder in Fleitmann's method of preparing oxygen.

A small quantity of the moist precipitated hydrate from the last experiment, which had been washed in the cold till free from adhering permanganate, was placed in the flask, which was then filled with permanganate solution (about 5 grms. of the salt). The precipitate and the fluid were then boiled together, but, after two hours, only about 20 c.c. of gas had collected, which was found to be oxygen. Again, the flask was filled with the same quantity of permanganate, and a solution of 0.25 gm. of manganous sulphate added, and boiled; 46 c.c. of gas was collected, and shown to be oxygen; and it will be noticed that the quantity bears roughly the same ratio to the 200 c.c. collected in a former experiment that the manganous sulphate used here does to that used in the other case.

The reaction was then apparently definite, and it seemed worth while, if possible, to put it on a quantitative basis. Decinormal solutions of permanganate and of manganous sulphate were prepared, containing 3.16 grms. and 1.51 grms. of the salts respectively per litre. (The permanganate was rather above decinormal strength, 100 c.c. being equivalent to 100.4 c.c. decinormal solution.)

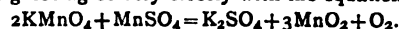
Into the flask was introduced 100 c.c. (=100.4) permanganate solution, and the air was then displaced by a stream of CO_2 ; 100 c.c. of MnSO_4 solution was added through the funnel tube without introducing air, and the liquid and precipitate boiled together for two hours, the gas given off being collected over caustic soda. After allowing for the small quantity of residual air in the flask, 23 c.c. of oxygen remained. The contents of the flask were poured on an asbestos filter, and the precipitate washed. The filtrate was perfectly colourless, and hence contained no permanganate. It gave no precipitate with

ammonic sulphide, and thus contained no manganese; so that the whole of the manganese both of the permanganate and the manganous salt had gone into the precipitate. The precipitate was run into excess of potassic iodide solution, as suggested by Pickering (*Four. Chem. Soc.*, 1879, page 654), and the available oxygen determined by titration with hypo.

The results are as follows:—

Total Mn in precipitate (calc. from salts used)	0.1654
Equivalent O calculated	0.0482
Available O found	0.0475
Total available O in KMnO_4 used.. ..	0.0803
O found, $0.0475 + 0.0329$ (gas)	0.0804

These figures agree very closely with the equation—



The precipitate contains manganese and oxygen in proportions which agree very closely with the formula MnO_2 . Potassium in the precipitate was not looked for, but it doubtless was present, as in all similarly formed oxides which have been examined. The very close agreement between the observed "total available oxygen" and that calculated from the KMnO_4 is to be attributed to accident, because the gas measurements throughout were of the very roughest, and I have not based any quantitative conclusions on them, but have relied entirely on the determination of the oxygen in the precipitate, being content to find that the gas measurement approached at all closely to the difference between that and the total available oxygen in the permanganate.

The experiment was now repeated, using 200.8 c.c. KMnO_4 and 100 c.c. MnSO_4 . Oxygen given off, 19 c.c. = 0.0262 gm. Filtered as before. The filtrate was made up to 500 c.c., and the KMnO_4 and total manganese determined in portions by ferrous sulphate and permanganate, and by reduction by SO_2 , precipitation as sulphide, and conversion into sulphate respectively. The filtrate contained KMnO_4 equivalent to 107.1 c.c. decinormal solution, whence 93.7 c.c. had gone into the precipitate. The manganese in the filtrate was 0.1150 gm., and that calculated from the KMnO_4 present 0.1178 gm., so that the whole of the manganese from the MnSO_4 was in the precipitate. The precipitate was treated as before:—

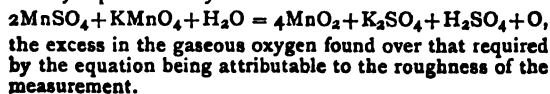
Total Mn calculated from 93.7 c.c. KMnO_4 and 100 c.c. MnSO_4	0.1581
Equivalent O calculated	0.0460
Available O found	0.0457
Total available O in KMnO_4	0.0750
Found $0.0457 + 0.0262$ (gas)	0.0719

Here again the precipitate is practically MnO_2 (with possible K_2O), and the same equation would represent the reaction, only that the amounts of KMnO_4 used up, and of oxygen given off, are somewhat below those required by the equation, a portion of the oxygen which before came off as gas appearing to have done the work of the 6.3 c.c. of KMnO_4 .

In the next experiment 200 c.c. MnSO_4 solution was used, and 100 (= 100.4) c.c. KMnO_4 . The oxygen given off was 12.8 c.c. = 0.0170 gm. The filtrate was this time colourless, and contained no manganese. The precipitate showed 0.0638 gm. available O:—

Total Mn in precipitate (calc. from salts used)	0.2208
Equivalent O calculated	0.0642
Available O found	0.0638
Total available O in KMnO_4	0.0803
Found $0.0638 + 0.0170$ (gas)	0.0808

Again the precipitate is MnO_2 , and the reaction is very closely represented by—



The same experiment was repeated with 150 c.c. MnSO_4

solution and 50.2 c.c. KMnO_4 . Oxygen given off, 2.1 c.c. = 0.0027 gm. Filtrate contained no manganese:—

Total Mn in precipitate (calc. from salts used)	0.1377
Equivalent O calculated	0.0400
Available O found	0.0375
Total available O in KMnO_4	0.0402
Found $0.0375 + 0.0027$ (gas)	0.0402

This time the precipitate exhibits a distinct deficiency in oxygen, the figures calculating out to a mixture of 0.0111 gm. MnO with 0.2040 gm. MnO_2 , or a formula of approximately $\text{MnO}_{1.15}\text{MnO}_2$. The equation here would seem to be that on which Guyard based his volumetric process,—
 $3\text{MnSO}_4 + 2\text{KMnO}_4 + 2\text{H}_2\text{O} = 5\text{MnO}_2 + \text{K}_2\text{SO}_4 + 2\text{H}_2\text{SO}_4$,
 only that a small portion of the oxide has broken up, giving off part of its oxygen.

200 c.c. MnSO_4 solution and 50.2 c.c. KMnO_4 were now boiled together. Practically no gas was given off. Filtrate contained no KMnO_4 , but showed manganese equivalent to 0.0552 gm. MnSO_4 , whence 0.3120 gm. corresponding to 170 c.c. decinormal solution, had gone to form the precipitate:—

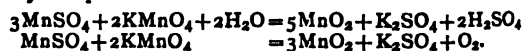
Total Mn in precipitate	0.1485
Equivalent O calculated	0.0432
Available O found	0.0396

So that in this case, again, the oxide is deficient in oxygen, the nearest formula being $\text{MnO}_{1.11}\text{MnO}_2$. Here, then, Guyard's equation probably holds in the first case, but the oxide formed takes up more manganese from the excess of sulphate present.

Two experiments were then tried in the cold, one with 100 c.c. of each of the solutions, the other with 150 c.c. MnSO_4 and 50 c.c. KMnO_4 . A few small gas bubbles detached themselves, and both precipitates exhibited small deficiencies in oxygen, but the results agreed approximately in both cases with Guyard's equation.

As a result of the whole, it seems that when permanganate and manganous sulphate react on each other in the cold the reaction is approximately expressed by Guyard's equation, and any excess of either salt over the proportion represented by $3\text{MnSO}_4 : 2\text{KMnO}_4$ remains unacted on; but that this statement is only approximate, that the precipitate always contains less oxygen than corresponds to the formula MnO_2 , and that this deficiency in oxygen is not attributable to the escape of oxygen gas (which appears, however, to take place to a very small extent when the permanganate is in excess), but to the fact that rather more MnSO_4 and rather less permanganate enter into the reaction than the equation represents.

When the solutions are boiled together two reactions may take place:—



If the salts are in the proportions required for the first reaction, this reaction takes place almost exactly; there is, however, a tendency for the precipitate to be low in oxygen, which is increased if the amount of MnSO_4 present exceeds that required by the equation. If the ratio which the quantity of KMnO_4 bears to that of MnSO_4 is between that required for the first equation and that required for the second, the whole of the manganese of both salts is precipitated, the precipitate has the composition MnO_2 , and the whole of the oxygen of the permanganate in excess of that required to form MnO_2 with the whole of the manganese is given off in the gaseous form. If more KMnO_4 is present than is required for the second equation, the excess remains practically unacted upon.

It is to be noted, however, that the solutions with which I have worked are very weak ones, and that Wright and Menke (*Four. Chem. Soc.*, 1880, page 23) have shown that with the same proportions of KMnO_4 and MnSO_4 the strength of the solutions used influences the composition of the precipitate, which exhibits a greater deficiency of oxygen as the strength of the solutions in-

creases. The evolution of oxygen, however, when the permanganate is in excess of the quantity required for Guyard's equation, takes place both in strong and weak solutions. This decomposition of the permanganate, too, would seem to be the cause of the high results which, as they state, Wright and Menke obtained with their modification of Guyard's volumetric process when the permanganate solution was used hot; and in this connection it would seem desirable to examine a little more closely than I have been able to the action of the hydrate precipitated in the cold upon hot solutions of permanganate.

Professor HERSCHEL exhibited, for Mr. J. B. Payne, a new cheap form of voltaic cell, invented by Mr. Alfred Bennett, of Glasgow. It consisted of an inner porous cell containing zinc in caustic soda solution, packed in iron filings contained in an outer cell which was made out of an Australian meat tin. Twelve of these cells in series kept a small Swan lamp glowing brightly, and it is claimed for the battery that it keeps up its electromotive force for a very long time.

NOTICES OF BOOKS.

Handbook of the Polariscopes and its Practical Applications. Adapted from the German Edition of H. LANDOLT, Professor of Chemistry at the Polytechnicum, Aachen, by D. C. ROBB, B.A., and V. H. VELEY, B.A., F.C.S., with an appendix by T. STEINER, F.C.S. London: Macmillan and Co.

THE appearance of this work in an English version appears to be due, in the first instance, to Mr. F. Faulkner, of St. Helens. At his request a translation was executed by Mr. H. M. Chichester, and the manuscript was placed in the hands of Mr. Robb for revision and editing. This gentleman, in his preface, takes upon himself the responsibility, though not all the credit of the work, but his death, about a year ago, not merely led to considerable delay, but necessitated a last revision by Mr. Veley. We are, therefore, brought in contact with five distinct minds, and cannot presume to determine what share of credit is due to each.

As to the need for a treatise of this nature there can be no question. Now that physical and especially optical properties are so largely used in identifying and characterising organic compounds, such a manual ought to be accepted as no trifling boon. Strange as it may sound, we have from time to time received communications from persons of some standing in the chemical world seeking the meaning of symbols in which the rotatory power of different bodies is expressed. The treatise before us is at once theoretical and practical; the authors explain the polarisation of light in its various phases, and especially the nature of rotatory power. They then proceed to the process of determining specific rotation, and ultimately to the application of the methods in quantitative analysis.

We find, as an introduction, an account of the difference between ordinary and polarised light, of polarisation by reflection, and of the simple polariscope. The reader is then made acquainted with the rotation of the plane of polarisation, or, as it is commonly called, circular polarisation.

In the second chapter we find a classification of optically active substances. There are those—either organic or inorganic—which possess the power of rotating the plane of polarisation only when solid and in a crystalline state. If dissolved or melted they become inactive. Again, there are bodies which possess rotatory power when dissolved, and if volatile, even in the gaseous state. These substances, if capable of crystallisation, become inactive when crystalline. There is yet a third class which possess rotatory power, both when crystallised and when dissolved. So far as is yet known all the substances

belonging to the last two classes are organic bodies,—either naturally occurring in plants and animals, or derived from them by simple metamorphoses. Thus we find here the sugars, the gums, many of the principal vegetable acids, a number of the essential oils and camphors, alkaloids, the gelatinous substances, and the soluble albumens and peptons. Hence it would seem that the power of circular polarisation in solutions as distinct from crystals is a property of the carbon atom. We do not know whether optical action and inaction in organic matter have been brought respectively into relation with the functions of the several compounds in the organic system. The fact that the albumens are all active may be of some importance.

The nature of rotatory power and its dependence upon chemical constitution are next discussed, with especial reference to the theories of Pasteur, Le Bel, and Van't Hoff. The conclusion of the last-mentioned chemist that optically active substances invariably contain one or more asymmetrical carbon atoms, and the converse proposition that substances containing no asymmetrical carbon atoms display no optical activity, are not in opposition to any known facts. But Van't Hoff admits that not all bodies containing asymmetrical carbon atoms are optically active. The physical laws of circular polarisation are next laid down, the amount of rotation being shown to be dependent on the thickness of the medium and on the wave-length of the transmitted ray. These and connected considerations lead to the actual process for determining specific rotation. Here the various kinds of apparatus used are described and carefully figured; first, such as merely indicate the direction of the rotation as right or left, and such as in addition measure its quantity. The latter are divided into two classes: the polariscopes or polaristobometers, which are applicable to all optically active substances, and the saccharimeters, adapted for sugar. The account of these instruments, with the needful directions for their use, takes up the bulk of the remainder of the volume, and must be pronounced ably written with every regard to the needful precautions and niceties.

Mr. Steiner's appendix treats on the estimation of maltose and dextrine in malt worts and beers, and will be exceedingly useful to brewers.

The work is very carefully got up, and so far as we have observed is free from clerical and typographical errors.

The Dry Closet System: its Adaptation to the City of Hereford and other Urban Districts. By JAMES HAIN. Hereford: Hereford Times Office.

THE author of this pamphlet very sensibly protests against the proposed establishment of an irrigation farm as a method of disposing of the sewage of the city of Hereford. But he is equally unfavourable to precipitation, declaring it "a chemical impossibility to prepare by precipitation from sewage a manure which shall pay the cost of its production when its true commercial value is found either by practical experience or trustworthy analysis." He objects, in fact, to the water-closet system altogether, and recommends in preference dry closets. Unlike Mr. Moule and others, however, he proposes to absorb the excreta, not in coal-ashes, dry earth, or the like, but in a mixture of "equal quantities of peat charcoal dust and hot air-dried phosphate of lime, containing about 37 to 39 per cent of phosphoric acid,"—a composition which he pronounces an "effective and most valuable deodoriser." He recommends also the addition of a few handfuls of vitriolised shoddy to be placed in each pail each time it is replaced to receive the excreta. That the analytical value of the manure thus produced will be greater than that of an ordinary dry-closet system where the fæces are received in clay, &c., is a simple truism, but the working cost must be increased in the same proportion. When the contents of the pails are collected together, he would add sulphuric acid, so as to dissolve the phosphate, yielding a manure

which would "contain about 20 per cent soluble phosphates, 8 to 9 per cent insoluble phosphates, and 14 to 2 per cent of ammonia." The kind of phosphate which the author has in view appears to be coprolites.

Suppose we take a mixture of equal parts of the best Cambridge coprolite at 66 per cent tricalcic phosphate and of peat charcoal, we shall have only 33 per cent total phosphate to begin with, and add to each 100 lbs. of the mixture the, say, 30 lbs. of sulphuric acid necessary to dissolve the phosphate, we shall have only a total of 25 per cent tricalcic phosphate to work upon, even if we overlook the fact that the absorbed faecal matters must reduce the relative proportion of the other constituents present. But to obtain 20 per cent soluble phosphate and 8 or 9 per cent insoluble phosphate out of a total percentage of 25 phosphate is manifestly impossible, since about 30 per cent tricalcic phosphate will have to be completely dissolved to yield the 20 per cent soluble phosphate. It must further be remembered that sulphuric acid acts less advantageously upon phosphatic minerals if the latter have been previously mixed, say, with charcoal.

An analysis is given of the concentrated manure made by the Health Committee of the Manchester Corporation. In it we find present phosphoric anhydride 1.445 per cent = 3.177 tricalcic phosphate, and about 3.64 per cent ammonia. Now before us lies the analysis of a sewage manure made by precipitation containing tricalcic phosphate 4.61 and ammonia 1.94 per cent, whilst another sample from the same place—Aylesbury—is certified by a perfectly independent authority to contain 3.41 per cent of nitrogen. It does not appear, therefore, that the "pail-system" manure has any distinct advantage over that obtained by precipitation.

Nitroglycerin in Angina Pectoris. By W. MURRELL, M.D., M.R.C.P. London: H. K. Lewis.

CONCERNING the physiological action of nitroglycerin, observers differ. Whilst some persons have experienced alarming symptoms from taking 2 drops of a one per cent solution in alcohol, others have taken quantities equal to 50 and even 100 such drops without any marked effect. In some cases it produces unpleasant effects even when handled. The author makes the alarming statement that small quantities are manufactured even in London,—an offence for which the Explosives Act provides no remedy at all adequate. It is a singular piece of inconsistency that while additional restrictions are proposed on the sale of poisons, explosives of the most dangerous kinds can be purchased practically without restraint.

Dr. Murrell has used nitroglycerin with success in the treatment of angina pectoris. The details of the cases have a purely medical interest.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 11, March 13, 1882.

Double Decompositions of the Haloid Salts of Mercury.—M. Berthelot.—A thermo-chemical paper, not admitting of useful abridgment.

Kinetic Theory of Gases and the Vibratory Condition of Matter.—A. Leduc.—The conclusions drawn in this long mathematical paper are: The present theory of gases presents at its origin a *secondary* kinetic hypothesis which is quite gratuitous, and three errors of principle. The theory of gases must be taken up anew *ab ovo* upon more rigorous bases, even though it may furnish less bril-

liant results. As to the general kinetic hypothesis, it is not attacked in the present discussion. The vibratory state of the ultimate particles of matter is now incontestable, since it rests expressly upon the principle of the mechanical equivalence of heat, which is one of the best-established scientific truths.

Crystalline Gallium Oxychloride.—Lecoq de Boisbaudran.—In 1878 the author prepared and sealed up in a tube, a specimen of hydrated gallium chloride in the gelatinous state. Last summer it was found converted into a mass of crystals immersed in a liquid. On examination the liquid was found very acid. The crystals were of an octahedral form, their apices being truncated by small facettes. They have no action upon polarised light, and are scarcely, if at all, soluble in water or in cold nitric acid. It dissolves slowly in cold hydrochloric acid, and immediately in caustic potassa. These crystals consist of one mol. of chloride with 12Aq, corresponding to that of aluminium, and two mols. of mono-hydrated oxide, corresponding to mono-hydrated alumina. The hydrochloric solution of the crystals gives a brilliant spectrum of gallium.

Tempering by Compression.—M. Clémendot.—The author heats metals, and especially steel, to a cherry-red, compresses them strongly, and keeps up the pressure till the mass is perfectly cold. The metal acquires an excessive hardness, and a striking fineness of grain. Steel thus treated acquires a coercitive force, which enables it to become magnetic. The durability of this property requires to be studied.

Compressibility of Gases.—E. Sarrau.—The author gives his results for carbonic acid, nitrogen, and marsh-gas. He is not aware of any experiment to verify the elements of the critical point as calculated for nitrogen and formene.

Boiling-Point of Zinc.—J. Violle.—The author's experiments, several times repeated, show a temperature of 930°.

Hydro-dynamic Experiments (Note 4).—C. Decharme.—The author produces, by means of liquid currents, an imitation of the rings of Nobili, as obtained with electric currents. The author proceeds as follows:—Upon a horizontal plate of glass covered with a thin and uniform layer of red lead, barium sulphate, or any other insoluble powder held in suspension in water, he lets fall from a graduated glass tube a slender stream of water. The tube is held vertically at the height of 0.01 to 0.10 metre above the plate. These rings do not display the iridescent colours of Nobili's rings, but this distinction is not absolute.

Apparatus for Regulating the Flow of a Gas at any Pressure.—J. Ville.—Not susceptible of useful abstraction.

Formation-heat of Hydro-ferrocyanic Acid and of certain Ferrocyanides.—M. Joannis.—Hydrocyanic acid is a true bibasic acid, very similar to hydrochloric acid in the quantities of heat which it liberates with the alkalies and alkaline earths.

Products of the Distillation of Resin.—A. Renard.—The portions which pass over about 150° comprise three hydrocarbons, a terebenthene, and two isomeric carbides, C₁₀H₁₈. Those going over between 154° and 157° appear to be a mixture of a terebic carbide, C₁₀H₁₆, and a hydrocarbide, C₁₀H₁₈.

The Titration of Tannin and Œnogallic Acid in Wines.—F. Jean.—The author evaporates on the sand-bath 100 or 50 c.c. of the wine, so as to reduce its bulk to a few c.c. He mixes the residue with dry, precipitated silica, and dries the whole in the stove at 60° to 70°. The mass is then powdered, placed in a small extruding apparatus, and exhausted with ether, mixed with a small quantity of hydrochloric ether. The ethereal solutions are evaporated in the water-bath, and the residue is taken up in 100 c.c. distilled water. In 10 c.c. of this solution

the tannin and the cenogallic acid are titrated with solution of iodine, according to the author's method indicated for the volumetric determination of astringent bodies (*Comptes Rendus*, 1876). The solution must be neutralised before adding bicarbonate of soda, so that the astringent acids may always be in presence of the same quantity of alkaline bicarbonate. The rest of the aqueous solution is then agitated in contact with a small excess of rasped hide to fix the tannin, strained, and the cenogallic acid is determined in 10 c.c. of the filtrate by means of the solution of iodine. The second result shows the cenogallic acid, and is deducted from the former, which represents the joint weight of tannin and cenogallic acid. The difference shows the volume of iodine solution, which corresponds to the tannin contained in the wine. The standard of the iodine solution is ascertained in reference to a known weight of pure tannin, and as the gallic acid acts upon the iodine in the same proportion as the tannin, it is easy to calculate both the tannin and the cenogallic acid contained in the wine.

Chloruration of Camphor; Formation of Camphor Bichloride.—P. Cazeneuve.—The author dissolves camphor in absolute alcohol, and when the solution is cold passes through it a current of dry chlorine for four or five days. The compound, when purified, forms prisms of an intense white, insoluble in water, soluble to any extent in hot alcohol. It liquefies in contact with the vapour of ether.

Gastric Digestion.—E. Duclaux.—The author has discovered in certain ferments of caseine, a diastase capable of transforming this substance into a peptone, similar to those met with in the digestive canal.

Chemical Action of Different Metals upon the Heart of the Frog.—C. Richet.—The author in his present way of experimenting, finds no relation between the "toxicity" of metals, even of the same family, and their atomic weight. Lithium is more poisonous than sodium, and palladium than platinum. The results when tabulated, differ notably from those obtained with the gills of fishes. Hence the toxicity of a substance varies according to the tissue with which it comes in contact. Among the metallic chlorides, some, such as those of barium, calcium, strontium, and cerium, arrest the heart in systole; others, such as potassium, cesium, rubidium, ammonium, nickel, cobalt, and magnesium, stop it in diastole. The remaining chlorides arrest it in an intermediate position.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 2, 1882.

True Chemistry.—A study by M. E. Maumené.—The author discusses here the chemical action determined by heat between the elements of liquids and the mutual action of copper and sulphur. (We hope to return to this memoir.)

Electric Machines.—H. Valette.—An illustrated description of the Gramme machines.

No. 3, 1882.

This number contains no original chemical matter.

No. 4, 1882.

Differential Apparatus for Determining Ozone in the Air.—Dr. D. Tommasi.—The apparatus is formed of an aspirator fitted with a copper tube dividing at one end into two branches. To one of these is fitted, by means of caoutchouc tubing, a bulb tube, as commonly used for the determination of ammonia. To the other branch is attached a similar bulb-tube, fitted, on the side where the air enters, with a platinum tube 30 c.m. long by 1 c.m. in diameter, filled with platinum sponge. To use the apparatus, there is poured into the bulb tubes a known volume of a standard solution of sodium arsenite, and the platinum tube is heated by means of a gas or spirit flame.

The cock of the aspirator is then opened and air is allowed to pass slowly through. After a time the current of air is shut off, and the quantity of sodium arseniate formed in each bulb-tube is determined by means of a standard solution of potassium permanganate. Let x be the quantity of arseniate found in the apparatus without the platinum tube, and y the quantity found in the other, $x-y$ will represent the proportion of ozone in the air. In the first tube is determined, not merely the ozone, but all substances which may have an oxidising action upon sodium arsenite. In the apparatus fitted with the platinum tube are determined the oxidising products less the ozone, which is transformed into ordinary oxygen in its passage over the heated platinum sponge.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. x., Part 12.

Two Instruments for the Analysis of Milk.—Dr. A. Adam and A. Pinchon.—Adam uses for the analysis of milk, a burette fitted below with a glass cock, provided with two ball-shaped enlargements, and capable of being closed with a cork. This burette (the galactotimeter) is graduated below, and between the balls there is a mark up to which it holds 10 c.c. On the upper ball is a second mark, indicating 22 c.c. more, or in all 32 c.c. Ten c.c. of milk are sucked in, the cock is closed, and a little more than 22 c.c. of alcohol, ether, and ammonia in mixture are added. The instrument is shaken, when the alcoholic ethereal liquid seizes the butter. The two strata are allowed to separate, and the lower one, which is now free from fat, is run out through the cock, and can be used for the determination of the caseine. The solution of fat is shaken up first with water and then with dilute acetic acid, which, after settling, is let off by the cock; a little more dilute acetic acid is then added, so that the solution of fat is in the ball. The ether and alcohol are then expelled by plunging the burette into hot water. The stratum of acid liquid is let off at the top, so that the liquid fat passes into the graduated part of the instrument and is there measured. The figures show the number of grammes of fat contained in a litre of milk. Pinchon takes advantage of the unequal expansion of normal milk, skimmed milk, and diluted milk on being heated from the common temperature to from 50° to 55°. He has constructed upon this principle an instrument with scales and tables.

Adulteration of Butter.—MM. Johanson, Mayer, and others.—In Holland, besides the more liquid portion of tallow, the oil of arachis (earth-nut oil) is largely used. Mayer recommends for the detection of spurious butter, Bell's process as modified by Estcourt. The specific gravity of the sample is taken at 100°, genuine butter having a higher specific gravity than other fats and oils. In Chicago, lard is largely mixed with butter.

Use of Strontianite for Obtaining Sugar from Molasses.—Prof. C. Scheibler.—A main advantage of substituting strontia for lime is that the saccharate of strontia is granular and not gelatinous, like the corresponding lime compound. Three mols. strontia are required to 1 mol. sugar. On the large scale the author considers it possible to precipitate 99 per cent. of the sugar present in molasses as a strontia compound.

Vol. xi., Part 1.

Utilisation of the Refuse Waters of Manufactures in Artificial Meadows in Lüneburg.—Carl Drewsen.—The author describes the application of the waste-waters of a paper mill for the irrigation of heath-land and sands, near Celle.

Action of Vegetation upon the Quantity of Substances withdrawn from the Soil by Rainfall.—E. W. Prevost.—From the *Journal of the Chemical Society*.

Studies on the Weathering of Orthoclase.—Julius Stocklase.—The author divides the weathering-process into three stages. In the first occur decrease of hardness, increase of the proportion of water, and separation of ferric hydroxide. In the second stage there are formed silicates readily soluble in weak acids; alkalies, chiefly soluble in concentrated hydrochloric acid, increase; the density decreases, and the moisture increases. In the third stage, the outer layers are converted into China clay, whilst the silicates are lixiviated out.

Power of Certain Salts to Arrest Ammonia.—Dr. A. Morgen.—Gypsum and magnesium chloride are especially efficacious in preventing the escape of ammonium carbonate. Magnesium sulphate, kainite, and kieserite may also be used with advantage where they can be procured cheaply.

The Value of Cesspool Manure.—Prof. F. Soxhlet.—The author gives analyses of poudrette made from the contents of the casks used for receiving excreta in Stuttgart, Heidelberg, and Augsburg, and the closet-liquid of Munich.

Action of Chili Saltpetre, Common Salt, and Potassium Chloride in the Soil.—C. F. A. Tuxen.—All these salts have a depressing effect on the absorption of ammonia and potassa; they convey these constituents of plant-food lower down into the earth, and prevent their appropriation by the arable layer. On the other hand, phosphoric acid is retained by the soil to a greater extent in the presence of sodium and potassium salts.

Manurial Experiments with Superphosphate and Bone-dust of Different Sizes of Grains.—Prof. F. Farsky.—In calcareous soils coarse superphosphate seems preferable to fine. Fine bone-dust also appeared to give a less satisfactory result than the coarser kinds.

The Excretion of Gaseous Nitrogen from the Animal Body.—Prof. J. Seegen, J. Nowak, and Dr. H. Leo.—The two first-mentioned authorities contend that the animal organism eliminates a part of the nitrogen derived from the decomposition of the albumenoids in the gaseous state. Dr. Leo shows that such an exhalation, if it takes place at all, must be practically unimportant in extent.

Electric Researches on Vegetable and Animal Tissues.—A. J. Kunkel.—The author ascribes the electric phenomena recorded to the imbibition and exhalation of water by the organic tissues.

Chemical Difference between Living and Dead Protoplasm.—O. Loew and T. Bokorny.—The authors trace vitality to the tension of aldehyd groups in the molecule of living protoplasm, and death to their displacement.

Bulletin de la Société Chimique de Paris,
Tome 37, Nos. 3 and 4, 1882.

A Trichloric Propane.—P. van Romburgh.—The trichlorinated propane formed by the action of phosphorus perchloride upon acroleine hydrochlorate, is not ordinary trichlor-hydrin, but rather appears to be identical with that which takes its rise as an accessory product in the preparation of allylidene chloride. The products of its decomposition under the influence of potassa show with sufficient certainty that the constitutional formula of the body ought to be $\text{CH}_2\text{Cl}-\text{CH}_2\text{CHCl}_2$. This is a new proof in favour of the theory which regards acroleine hydrochlorate as β -chloro-propionic aldehyd.

Influence of Heat and of the Proportions of Glycerin upon the Decompositions of Oxalic Acid.—M. Lorin.—On causing the respective proportions of oxalic acid and of glycerin to vary, the decomposition of the oxalic acid and the proportions of formic acid vary also. The final product is a poly-formine, of composition varying according to the conditions of the experiment; sometimes a

mono-formine nearly pure, sometimes a diformine, or mixtures of these bodies. It is not impossible that glyceric triformine may be obtained in experiments of this kind.

Essence of Angelica.—Laurent Naudin.—The author has obtained from the essence of the seeds, a compound isomeric with the oil of turpentine, and which he names terebangeline.

Action of Zinc Powder upon Bichlorated Terebenthene.—Laurent Naudin.—This compound is violently decomposed at 100° by traces of zinc powder.

Die Chemische Industrie.
Vol. 5, No. 1.

This number does not contain any matter other than abstracts of patent specifications.

*Verhandlungen des Vereins zur Beförderung des
Gewerbflusses.* February, 1882.

This issue contains no chemical matter.

Journal de Pharmacie et de Chimie.
January, 1882.

Electric Exhibition: Congress of Electricians.—This paper is composed of matter with which the scientific world is already familiar.

Manageable Zone of Anæsthetic Agents and a New Method of Chloroformisation.—P. Bert.—The author points out that in the use of anæsthetics the margin between efficiency and danger is very narrow.

New Notes on the Strychnos which Furnishes the Curare of the Orinoco.—G. Planchon.—This memoir is of no chemical interest.

MEETINGS FOR THE WEEK.

MONDAY, 3rd.—Medical, 8.30.

Royal Institution, 5. General Monthly Meeting.
Society of Chemical Industry, 7.30. "The Chemical Technology of Jute Fibre," by C. F. Cross, B.Sc. Discussion on "Smoke Abatement."

Pathological, 8.30.

TUESDAY, 4th.—Institute of Civil Engineers, 8.

Anthropological Institute, 8. "The Papuans and Polynesians," by C. Staniland Wake. "Rites and Customs in Old Japan," by C. Pfouder.

WEDNESDAY, 5th.—Geological, 8.

Pharmaceutical, 8.
Obstetrical, 8.

THURSDAY, 6th.—Chemical, 8. "Observations on the Action of Acetylic Chloride on Fumaric Acid," by W. H. Perkin; "Note on a Convenient Apparatus for the Liquefaction of Ammonia," by J. Emerson Reynolds; "Transformation of Urea in Cyanamide," by H. J. H. Fenton; "Some Arguments in favour of Ladenburg's Prismatic Formula of Benzene," by M. K. Dutt.

FRIDAY, 7th.—Geologists' Association, 8.

COLLEGE OF PHYSICAL SCIENCE,
NEWCASTLE-UPON-TYNE.

A PROFESSOR OF CHEMISTRY for this College will be elected on the 5th June. Salary £300, with two-thirds of the Lecture Fees and one-third of the Laboratory Fees of Students of the College. The appointment is open to competition, and candidates for the office are invited to apply (with testimonials) to THOS. WOOD BURNING, Secretary to the College of Physical Science, Newcastle-upon-Tyne, before Saturday, the 29th April, from whom full particulars as to duties, &c., may be obtained.

A Thoroughly Competent Analytical Chemist is required to go abroad under a three years' engagement. Must be skilled in assaying and mineralogy. Age from 30 to 35 years. Salary £300 per annum. Must be prepared to enter upon his duties now.—Address copies of testimonials and references, with any details considered necessary, to S. H. R., care of Messrs. G. Street and Co., 30, Cornhill, London, E.C.

THE CHEMICAL NEWS.

VOL. XLV. No. 1167.

ON THE MOVEMENT OF GAS IN "VACUUM" DISCHARGES.*

By WILLIAM SPOTTISWOODE, P.R.S., and J. FLETCHER MOULTON, F.R.S.

In the preparation of tubes for our experiments it was often noticed that, after the exhaustion had been carried to a certain degree, the passage of a strong current had the effect of increasing the pressure. This appeared to be due to an expulsion of gas from the terminals themselves by the passage of the discharge. And accordingly the use of such currents from time to time during the process of exhaustion was adopted for making the vacuum more perfect and more permanent than otherwise would have been the case. On the other hand, it was also noticed that after the tube had been taken off the pump and sealed in the usual way, the passage of a strong current had in some instances the effect of decreasing the pressure. We thus met with two effects, apparently due to the same cause, but diametrically opposite in character.

The fact of the tube being on the pump or off it did not appear to be at all material to the question, because the first effect could be obtained when the tube was temporarily shut off by a stopcock. Nor indeed did either the first or the second effect depend upon the absolute pressure, although neither was observed except when the pressure was such as to approach the stage when Crookes's phosphorescence was produced.

These phenomena also reproduced themselves in another way. Some tubes, after having been completed and taken off the pump, showed a decreased pressure after a prolonged passage of a strong current, others an increased pressure, but among both classes tubes were not unfrequently found which recovered their original pressure after a period of rest or cessation of discharge.

Matters remained in this rather confused state until we observed, with more care than before, a tube of which the exhaustion was near the phosphorescent state, and of which both terminals were metallic cones, and consequently presented large surfaces for any action which might take place upon them.

In what may be considered to have been its normal condition this tube showed three or four large white striæ, with a Crookes's space of considerable size round the negative terminal. On passing the discharge through the tube for some minutes the Crookes's space increased, the striæ became fewer and feebler in illumination, the green phosphorescence began to show itself, and the discharge showed the usual signs of reduced pressure. On suddenly reversing the current the striæ became again more numerous and more brightly illuminated, precisely as they would be by an increase of pressure, while the other features of the discharge in a great measure resumed their original character; and not only so, but by a comparatively slow process, occupying many seconds in duration, the indications of increasing pressure continued still further, until they implied a pressure even beyond that at which the tube stood when the experiments began. This reversal of the discharge was repeated many times with the same result in every case. The amount of change in pressure indicated by the appearance on each reversal was found to depend within wide limits upon the duration of the previous discharge, or, what is the same thing, upon the amount of depression below the normal pressure indicated by the previous discharge.

* A Paper read before the Royal Society, March 30th, 1882.

The only explanation of these phenomena appears to be this,—that the effect of the discharge is actually to alter the pressure in the tube, not by any modification in the chemical composition of the gas, still less by anything that could be represented as a destruction of matter, but simply by driving occluded gas out of one terminal, and by drawing it in, or occluding it, at the other. On reversing the discharge the operation is reversed, and the occluded contents of one terminal are thrown along the tube to be occluded at the other. This view of the mechanism whereby the observed phenomena are produced is supported by the absence of these appearances when the terminals are comparatively small and the pressure is such that the occluded contents of the metallic mass forming one terminal would form only a small fraction of the total mass of gas in the tube; for in that case the pressure, and consequently the appearance of the discharge, would be affected only in an inappreciable degree by the injection of the contents of the terminal. It should also be added that, when the terminals are of unequal size, the effects are unequal, as might have been expected.

The phenomenon in question appears to have so important a bearing on the mechanism of the discharge itself that it becomes a question of great interest to determine whether the ejection takes place at the positive, and the occlusion at the negative, terminal, or *vice versa*. For this purpose we have devised a tube with three terminals, but have not yet had time to complete its construction or to make the experiment.

ON THE CONSERVATION OF SOLAR ENERGY.*

By C. WILLIAM SIEMENS, D.C.L., LL.D., F.R.S.,
Mem. Inst. C.E.

THE question of the maintenance of Solar Energy is one that has been looked upon with deep interest by astronomers and physicians from the time of La Place downward.

The amount of heat radiated from the sun has been approximately computed, by the aid of the pyrheliometer of Pouillet and by the actinometers of Herschel and others, at 18,000,000 of heat units from every square foot of its surface per hour, or, put popularly, as equal to the heat that would be produced by the perfect combustion every thirty-six hours of a mass of coal of specific gravity = 1.5 as great as that of our earth.

If the sun were surrounded by a solid sphere of a radius equal to the mean distance of the sun from the earth (95,000,000 of miles), the whole of this prodigious amount of heat would be intercepted; but considering that the earth's apparent diameter as seen from the sun is only seventeen seconds, the earth can intercept only the 2250-millionth part. Assuming that the other planetary bodies swell the amount of intercepted heat by ten times this amount, there remains the important fact that 999,999,990 of the solar energy is radiated into space, and apparently lost to the solar system, and only 10,000,000 utilised.

Notwithstanding this enormous loss of heat, solar temperature has not diminished sensibly for centuries, if we neglect the periodic changes, apparently connected with the appearance of sun-spots that have been observed by Lockyer and others; and the question forces itself upon us how this great loss can be sustained without producing an observable diminution of solar temperature even within a human lifetime.

Amongst the ingenious hypotheses intended to account for a continuance of solar heat is that of shrinkage, or gradual reduction of the sun's volume suggested by Helmholtz. It may, however, be urged against this theory that the heat so produced would be liberated throughout its mass, and would have to be brought to the surface by

* A Paper read before the Royal Society.

conduction, aided perhaps by convection; but we know of no material of sufficient conductivity to transmit anything approaching the amount of heat lost by radiation.

Chemical action between the constituent parts of the sun has also been suggested; but here again we are met by the difficulty that the products of such combination would ere this have accumulated on the surface, and would have formed a barrier against further action.

These difficulties have led Sir Wm. Thomson, following up Mayer's speculation, to the suggestion that the cause of the maintenance of solar temperature might be found in the circumstance of meteorolites falling upon the sun from great distances in space, or with an acquired velocity due to such fall, and he shows that each pound of matter so imported would represent a large number of heat units depending upon the original distance. Yet the aggregate of material that would thus have to be incorporated with the sun would tend to disturb the planetary equilibrium, and must ere this have shortened our year to an extent exceeding that resulting from astronomical records and observation. In fact Sir William Thomson soon abandoned the meteoric hypothesis for that of simple transfer of heat from the interior of a liquid sun to the surface by means of convection currents, which latter hypothesis appears at the present time to be supported by Prof. Stokes and other leading physicists.

But if either of these hypotheses could be proved we should only have the satisfaction of knowing that the solar waste of energy by dissipation into space was not dependent entirely upon loss of its sensible heat, but that its existence as a luminary would be prolonged by calling into requisition a limited, though may be large, store of energy in the form of separated matter. The true solution of the problem will be furnished by a theory, according to which radiant energy which is now supposed to be dissipated into space, and irrecoverably lost to our solar system, could be arrested and brought back in another form to the sun itself, there to continue the work of solar radiation.

Some years ago it occurred to me that such a solution of the solar problem might not lie beyond the bounds of possibility; and although I cannot claim intimate acquaintance with the intricacies of solar physics, I have watched its progress, and have engaged also in some physical experiments bearing upon the question, all of which have served to strengthen my confidence and ripened in me the determination to submit my views, not without some misgiving, to the touchstone of scientific criticism.

For the purposes of my theory, stellar space is supposed to be filled with highly rarefied gaseous bodies, including hydrogen, oxygen, nitrogen, carbon, and their compounds, besides solid materials in the form of dust. This being the case, each planetary body would attract to itself an atmosphere depending for its density upon its relative attractive importance, and it would not seem unreasonable to suppose that the heavier and less diffusible gases would form the staple of these atmospheres; that, in fact, they would consist mostly of nitrogen, oxygen, and carbonic anhydride, whilst hydrogen and its compounds would predominate in space.

But the planetary system, as a whole, would exercise an attractive influence upon the gaseous matter diffused through space, and would therefore be surrounded by an interplanetary atmosphere, holding an intermediate position between the planetary atmospheres and the extremely rarefied stellar space.

In support of this view it may be urged that, in following out the molecular theory of gases as laid down by Clerk-Maxwell, Clausius, and Thomson, it would be difficult to assign a limit to a gaseous atmosphere in space, and, further, that some writers, among whom I will here mention only Grove, Humboldt, Zoellner, and Mattieu Williams, have boldly asserted the existence of a space filled with matter, and that Newton himself—as Dr. Sterry Hunt tells us in an interesting paper which has only just reached me—has expressed views in favour of such an assumption. Fur-

ther than this, we have the facts that meteorolites whose flight through stellar, or at all events through interplanetary space, is suddenly arrested by being brought into collision with our earth, are known to contain as much as six times their own volume of gases taken at atmospheric pressure: and Dr. Flight has only very recently communicated to the Royal Society the analysis of the occluded gases of one of these meteorolites taken immediately after the descent to be as follows:—

CO ₂	..	..	..	..	0.12
CO	..	..	..	..	31.88
H	..	..	..	..	45.79
CH ₄	..	..	..	..	4.55
N	..	..	..	..	17.66

100.00

It appears surprising that there was no aqueous vapour, considering there was much hydrogen and oxygen in combination with carbon; but perhaps the vapour escaped observation, or was expelled to a greater extent than the other gases by external heat when the meteorolite passed through our atmosphere. Opinions concur that the gases found occluded in meteorolites cannot be supposed to have entered into their composition during the very short period of traversing our atmosphere; but if any doubt should exist on this head, it ought to be set at rest by the fact that the gas principally occluded is hydrogen, which is not contained in our atmosphere in any appreciable quantity.

Further proof of the fact that stellar space is filled with gaseous matter is furnished by spectrum analysis, and it appears from recent investigation, by Dr. Huggins and others, that the nucleus of a comet contains very much the same gases found occluded in meteorolites, including "carbon, hydrogen, nitrogen, and probably oxygen," whilst according to the views set forth by Dewar and Living it also contains nitrogenous compounds such as cyanogen.

Adversely to the assumption that interplanetary space is filled with gases, it is urged that the presence of ordinary matter would cause sensible retardation of planetary motion, such as must have made itself felt before this; but assuming that the matter filling space is an almost perfect fluid not limited by border surfaces, it can be shown on purely mechanical grounds that the retardation by friction through such an attenuated medium would be very slight indeed, even at planetary velocities.

But it may be contended that if the views here advocated regarding the distribution of gases were true, the sun should draw to itself the bulk of the least diffusible, and therefore the heaviest gases, such as carbonic anhydride, carbonic oxide, oxygen, and nitrogen, whereas spectrum analysis has proved on the contrary a prevalence of hydrogen.

In explanation of this seeming anomaly it can be shown, in the first place, that the temperature of the sun is so high that such compound gases as carbonic anhydride and carbonic oxide could not exist within it, their point of dissociation being very much below the solar temperature; it has been contended, indeed, by Mr. Lockyer, that none of the metalloids have any existence at these temperatures, although as regards oxygen Dr. Draper asserts its existence in the solar photosphere: there must be regions, however, outside that thermal limit, where their existence would not be jeopardised by heat, and here great accumulation of these comparatively heavy gases that constitute our atmosphere would probably take place, were it not for a certain counterbalancing action.

I here approach a point of principal importance in my argument, upon the proof of which my further conclusions must depend.

The sun completes one revolution on its axis in 25 days, and its diameter being taken at 882,000 miles, it follows that the tangential velocity amounts to 1.25 miles per second, or to 4.41 times the tangential velocity of our earth. This high rotative velocity of the sun must cause

an equatorial rise of the solar atmosphere, to which Mairau, in 1731, attributed the appearance of zodiacal light. La Place rejected this explanation on the ground that the zodiacal light extended to a distance from the sun exceeding our own distance, whereas the equatorial rise of the solar atmosphere due to its rotation could not exceed 9-20ths of the distance of Mercury. But it must be remembered that La Place based his calculation upon the hypothesis of an empty stellar space (filled only with an imaginary ether), and that the result of solar rotation would be widely different if it was supposed to take place within a medium of unbounded extension. In this case pressures would be balanced all round, and the sun would act mechanically upon the floating matter surrounding it in the manner of a fan, drawing it towards itself upon the polar surfaces, and projecting it outward in a continuous disk-like stream.

By this fan action hydrogen, hydrocarbons, and oxygen are supposed to be drawn in enormous quantities toward the polar surfaces of the sun; during their gradual approach they will pass from their condition of extreme attenuation and extreme cold to that of compression, accompanied with rise of temperature, until on approaching the photosphere they burst into flame, giving rise to a great development of heat, and a temperature commensurate with their point of dissociation at the solar density. The result of their combustion will be aqueous vapour and carbonic anhydride or oxide, according to the sufficiency or the insufficiency of oxygen present to complete the combustion, and these products of combustion in yielding to the influence of centrifugal force will flow toward the solar equator, and be thence projected into space.

The next question for consideration is, What would become of these products of combustion when thus rendered back into space? Apparently they would gradually change the condition of stellar material, rendering it more and more neutral; but I venture to suggest the possibility, nay the probability, that solar radiation would, under these circumstances, step in to bring back the combined materials to a condition of separation by a process of dissociation carried into effect at the expense of that solar energy which is now supposed to be lost to our planetary system.

According to the law of dissociation as developed by Bunsen and Sainte-Claire Deville, the point of dissociation of different compounds depends upon the temperature on the one hand, and upon the pressure on the other. According to Sainte-Claire Deville the dissociation tension of aqueous vapour of atmospheric pressure, and at 2800° C., is 0.5, or only half of the vapour can exist as such, its remaining half being found as a mechanical mixture of hydrogen and oxygen, but that with the pressure the temperature of dissociation rises and falls, as the temperature of saturated steam rises and falls with its pressure. It is therefore conceivable that the temperature of the solar photosphere may be raised by combustion to a temperature exceeding 2800° C., whereas dissociation may be effected in space at comparatively low temperatures.

But these investigations had reference only to heats measured by means of pyrometers, but do not extend to the effects of radiant heat. Dr. Tyndall has shown by his exhaustive researches that vapour of water and other gaseous compounds intercept radiant heat in a most remarkable degree, and there is other evidence to show that radiant energy from a source of high intensity possesses a dissociating power far surpassing the measurable temperature to which the compound substance under its influence is raised. Thus carbonic anhydride and water are dissociated in the leaf-cells of plants, under the influence of the direct solar ray at ordinary summer temperature; and experiments in which I have been engaged for nearly three years* go to prove that this dissociating action is

obtained also under the radiant influence of the electric arc, although it is scarcely perceptible if the source of radiant energy is such as can be produced by the combustion of oil or gas.

The point of dissociation of aqueous vapour and carbonic anhydride admits, however, of being determined by direct experiment. It engaged my attention some years ago, but I have hesitated to publish the qualitative results I then obtained, in the hope of attaining to quantitative proofs.

These experiments consisted in the employment of glass tubes, furnished with platinum electrodes, and filled with aqueous vapour or with carbonic anhydride in the usual manner, the latter being furnished with caustic soda to regulate the vapour pressure by heating. Upon immersing one end of the tube charged with aqueous vapour in a refrigerating mixture of ice and chloride of calcium, its temperature at that end was reduced to -32° C., corresponding to a vapour pressure, according to Regnault, of 1-1800th of an atmosphere. When so cooled no slow electric discharge took place on connecting the two electrodes with a small induction coil. I then exposed the end of the tube projecting out of the freezing mixture, backed by white paper, to solar radiation (on a clear summer's day) for several hours, when upon again connecting up to the inductorium, a discharge, apparently that of a hydrogen vacuum, was obtained. This experiment being repeated furnished unmistakable evidence, I thought, that aqueous vapour had been dissociated by exposure to solar radiation. The CO₂ tubes gave, however, less reliable results. Not satisfied with these qualitative results, I made arrangements to collect the permanent gases so produced by means of a Sprengel pump, but was prevented by lack of time from pursuing the inquiry, which I purpose, however, to resume shortly, being of opinion that, independently of my present speculation, the experiments may prove useful in extending our knowledge regarding the laws of dissociation.

Assuming, for my present purpose, that dissociation of aqueous vapour was really effected in the experiment just described, and, assuming, further, that stellar space is filled with aqueous and other vapour of a density not exceeding the 1-2000th part of our atmosphere, it seems reasonable to suppose that its dissociation would be effected by solar radiation, and that solar energy would thus be utilised. The presence of carbonic anhydride and carbonic oxide would only serve to facilitate the decomposition of the aqueous vapour by furnishing substances to combine with nascent oxygen and hydrogen. By means of the fan-like action resulting from the rotation of the sun, the vapours dissociated in space to-day would be drawn towards the polar surfaces of the sun to-morrow, be heated by increase in density, and would burst into flame at a point where both their density and temperature had reached the necessary elevation to induce combustion, each complete cycle taking, however, years to be accomplished. The resulting aqueous vapour, carbonic anhydride, and carbonic oxide would be drawn towards the equatorial regions, and be then again projected into space by centrifugal force.

Space would, according to these views, be filled with gaseous compounds in process of decomposition by solar radiant energy, and the existence of these gases would furnish an explanation of the solar absorption spectrum, in which the lines of some of the substances may be entirely neutralised and lost to observation. As regards the heavy metallic vapours revealed in the sun by the spectro-scope, it is assumed that these form a lower and denser solar atmosphere, not participating in the fan-like action which is supposed to affect the light outer atmosphere only, in which hydrogen is the principal factor.

Such a dense metallic atmosphere could not participate in the fan action affecting the lighter photosphere, because this is only feasible on the supposition that the density of the in-flowing current is—at equal distances from the gravitating centre—equal or nearly equal to the outflowing

* See *Proc. Roy. Soc.*, vol. xxxi., March, 1880; and a paper read before Section A of the British Association, September 1, 1881, and ordered to be printed in the Report.

current. It is true that the products of combustion of hydrogen and carbonic oxide are denser than their constituents, but this difference may be balanced by their superior temperature on leaving the sun, whereas the metallic vapours would be unbalanced, and would therefore obey the laws of gravitation, recalling them to the sun. On the surface of contact between the two solar atmospheres intermixture, induced by friction, must take place, however, giving rise perhaps to those vortices and explosive effects which are revealed to us by the telescope, and have been commented on by Sir John Herschel and other astronomers. Some of the denser vapours would probably get intermixed and carried away mechanically by the lighter gases, and give rise to that cosmic dust which is observed to fall upon our earth in not inappreciable quantities. Excessive intermixture would be prevented by the intermediary neutral atmosphere, the penumbra.

As the whole solar system moves through space at a pace estimated at 150,000,000 of miles annually (being about one-fourth of the velocity of the earth in its orbit), it appears possible that the condition of the gaseous fuel supplying the sun may vary according to its state of previous decomposition, in which other heavenly bodies may have taken part. May it not be owing to such differences in the quality of the fuel supplied that the observed variations of the solar heat may depend? and may it not be in consequence of such changes in the thermal condition of the photosphere that sun-spots are formed?

The views here advocated could not be thought acceptable unless they furnished at any rate a consistent explanation of the still somewhat mysterious phenomena of the zodiacal light and of comets. Regarding the former we should be able to return to Mairau's views, the objection by La Place being met by a continuous outward flow from the solar equator. Luminosity would be attributable to particles of dust emitting light reflected from the sun, or by phosphorescence. But there is another cause for luminosity of these particles, which may deserve a passing consideration. Each particle would be electrified by gaseous friction in its acceleration, and its electric tension would be vastly increased in its forcible removal, in the same way as the fine dust of the Desert has been observed by Werner Siemens to be in a state of high electrification on the apex of the Cheops Pyramid. Would not the zodiacal light also find explanation by slow electric discharge backward from the dust towards the sun? and would the same cause not account for a great difference of potential between the sun and earth, which latter may be supposed to be washed by the solar radial current? May not the presence of the current also furnish us with an explanation of the fact that hydrogen, while abounding apparently in space, is practically absent in our atmosphere, where aqueous vapour, which may be partly derived from the sun, takes its place? An action analogous to this, though on a much smaller scale, may be set up also by terrestrial rotation giving rise to an electrical discharge from the outgoing equatorial stream to the polar regions, where the atmosphere to be pierced by the return flood is of least resistance.

It is also important to show how the phenomena of comets could be harmonised with the views here advocated, and I venture to hope that these occasional visitors will serve to furnish us with positive evidence in my favour. Astronomical physicists tell us that the nucleus of a comet consists of an aggregation of stones similar to meteoric stones. Adopting this view, and assuming that the stones have absorbed in stellar space gases to the amount of six times their volume, taken at atmospheric pressure, what, it may be asked, will be the effect of such a mass of stone advancing towards the sun at a velocity reaching in perihelion the prodigious rate of 366 miles per second (as observed in the comet of 1845), being twenty-three times our orbital rate of motion. It appears evident that the entry of such a divided mass into a comparatively dense atmosphere must be accompanied by a rise of temperature by frictional resistance, aided by attractive condensation. At

a certain point the increase of temperature must cause ignition, and the heat thus produced must drive out the occluded gases, which in an atmosphere 3000 times less dense than that of our earth would produce $6 \times 3000 = 18,000$ times the volume of the stones themselves. These gases would issue forth in all directions, but would remain unobserved except in that of motion, in which they would meet the interplanetary atmosphere with the compound velocity, and form a zone of intense combustion, such as Dr. Huggins has lately observed to surround the one side of the nucleus, evidently the side of forward motion. The nucleus would thus emit original light, whereas the tail may be supposed to consist of stellar dust rendered luminous by reflex action produced by the light of the sun and comet combined, as foreshadowed already by Tyndall, Tate, and others, starting each from different assumptions.

These are in brief the outlines of my reflections regarding this most fascinating question, which I venture to put before the Royal Society. Although I cannot pretend to an intimate acquaintance with the more intricate phenomena of solar physics, I have long had a conviction, derived principally from familiarity with some of the terrestrial effects of heat, that the prodigious and seemingly wanton dissipation of solar heat is unnecessary to satisfy accepted principles regarding the conservation of energy, but that it may be arrested and returned over and over again to the sun, in a manner somewhat analogous to the action of the heat recuperator in the regenerative gas furnace. The fundamental conditions are—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.
2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.
3. That these dissociated vapours are capable of being compressed into the solar photosphere by a process of interchange with an equal amount of reassociated vapours, this interchange being effected by the centrifugal action of the sun itself.

If these conditions could be substantiated we should gain the satisfaction that our solar system would no longer impress us with the idea of prodigious waste through dissipation of energy into space, but rather with that of well-ordered self-sustaining action, capable of perpetuating solar radiation to the remotest future.

ON THE SULPHATES OF ALUMINIUM.

By SPENCER UMFREVILLE PICKERING, B.A. Oxon.,
Assistant Master at Highgate School, and Chemical Lecturer
at Bedford College.

(Concluded from p. 135.)

VIII. *Decomposition of Basic Sulphates from Basic Solutions.*

WHEN a solution containing a basic sulphate of aluminium is left in the cold, it will continue to deposit a basic precipitate for many days, and even weeks. In order to ascertain whether this deposit thus formed is constant in composition or not, the filtrate from experiment 57 was allowed to stand for ten days, and the deposit then analysed. It was found to contain 66.169 per cent of alumina, or exactly the same amount as the original precipitate did. The filtrate from experiment 56 when similarly treated for a period of five days, gave a deposit containing 67.705 per cent of alumina, the original precipitate in this case having been less basic, since it contained only 66.149 per cent of alumina. A deposit obtained from a solution of aluminium sulphate, to which ammonia had been added in insufficient quantities to produce a permanent precipitate, has already been mentioned as containing 67.75 per cent of alumina.

Rammelsberg (*Pogg. Ann.*, 43, 583), repeating an experiment of Bauer's, kept a basic solution of aluminium sulphate for several years, and found that a deposit of crystalline appearance which had formed during that time contained 49.36 per cent of alumina. The author of the present paper has not been able to repeat this experiment exactly, but the above deposits gave no indications of crystalline structure under the microscope, and a rather strong basic solution on being allowed to stand for two months gave a deposit which might possibly have had some claims to being crystalline, but which on treatment with water dissolved to such a considerable extent that it evidently contained some of the normal salt mixed up with the basic deposit. On being repeatedly ground up and washed with water till it yielded but little sulphate to the wash-water, it was found to contain 66.54 per cent of alumina. The low percentage obtained by Rammelsberg, and the crystalline appearance noticed by him, is, therefore, in all probability due to the presence of some of the normal sulphate.

The above experiments, therefore, show that the deposits thus obtained are variable, and are not definite in composition.

IX. Basic Solutions diluted with Water.

When a solution containing a basic sulphate is diluted with water, a precipitate is obtained, increasing in amount as the quantity of water added is greater. In order to ascertain whether the precipitate thus formed was constant in composition or not the experiments given in Table V. were performed. In the first three experiments here quoted the solution employed was obtained by dissolving zinc in a strong solution of the normal sulphate at 100° until the first cloudiness appeared. Portions of this solution were diluted with 4, 100, and 500 volumes of cold water, and, as may be seen from the numbers in the third column, the precipitates thus thrown down increased regularly in basicity as the dilution was greater, although the amount of variation was by no means great. The last two experiments given in the table were performed with a solution obtained in a similar way to the above, except that only about one-half as much zinc had been allowed to dissolve in this case, and consequently the solution here was less basic; the results, however, indicate a variation in the same direction as the preceding ones do, although it is here rather greater, and both the precipitates are considerably less basic than the former ones.

Hence, on diluting basic solutions with water, the composition of the precipitate obtained varies with the extent of the dilution, and also with the basicity of the solution taken.

TABLE V.
Basic Solutions diluted with Water.

	Amount of Water added.	Approximate Amount of the total Al_2O_3 Precipitated.	Percentage of Al_2O_3 in the Anhydrous Precipitate.
63.	4 volumes	32 per cent	68.067
64.	100 "	44 "	68.435
65.	500 "	95 "	68.994
66.	25 "	42 "	65.312
67.	300 "	60 "	67.361

X. Attempts to Prepare an Acid Sulphate.

In order to ascertain whether aluminium is capable of combining with more sulphuric acid than exists in the normal sulphate, a solution of this latter salt was allowed to evaporate spontaneously after an equivalent of sulphuric acid had been added to it; but in this case, as well as in others in which the amount of acid present was increased, the only solid which ever made its appearance in the liquid consisted of the crystallised normal sulphate. Again, on boiling down some aluminium sulphate with a large excess of sulphuric acid until the whole solidified, an amorphous mass was obtained, and this, after thorough washing with cold water, in which it dissolved very

slowly, proved to be nothing but the anhydrous or partially hydrated normal salt. Hence, all attempts to obtain an acid sulphate of aluminium have so far been unsuccessful.

XI. Conclusion.

The experiments which have been detailed in the present communication tend to prove in the case of the sulphates of aluminium what a previous paper has proved in the case of the ferric sulphates. If they are considered satisfactory we must conclude that the whole body of basic sulphates of aluminium must be denied a place in our lists of definite chemical compounds; and it must be remembered that the present experiments are not mere repetitions of those of other chemists, proving that the results obtained are not always concordant, but that (in most of the cases at any rate) they clearly show that the substances actually obtained exhibit a constant variation in chemical composition with a variation of some of the physical conditions under which they are obtained.

In conclusion, it may be well to give a list of the sulphates which have been said to exist together, with the references to the papers treating of them.

1. $\text{Al}_2\text{O}_3, 2\text{SO}_3$, containing 38.954 per cent of alumina. Maus, *Pogg. Ann.*, xi., 80; Marguerite, *Comptes Rendus*, xc., 1354; Göbel, *Schw.*, 60, 401.
2. $2\text{Al}_2\text{O}_3, 3\text{SO}_3$, containing 45.97 per cent of alumina. Göbel, *Fahrbuch der Chemie und Physik*, 1830, iii.; Mill, *Quart. Journ. Sci.*, i., 1828, 382.
3. $3\text{Al}_2\text{O}_3, 4\text{SO}_3$, containing 48.906 per cent of alumina. Rammelsberg, *Pogg. Ann.*, 43, 583.
4. $\text{Al}_2\text{O}_3, \text{SO}_3$, containing 56.062 per cent of alumina. Maus (*loc. sup. cit.*); Debray, *Bull. Soc. Chim.*, (II.), vii., 9; Stromeyer, *Schweigger. Journ.*, 19, 424. See also analyses of Websterite, or aluminite.
5. $4\text{Al}_2\text{O}_3, 3\text{SO}_3$, containing 62.989 per cent of alumina. Debray (*loc. sup. cit.*)
6. $3\text{Al}_2\text{O}_3, 2\text{SO}_3$, containing 65.687 per cent of alumina. Lassaingne, *Ann. de Chemie*, 24, 97.
7. $5\text{Al}_2\text{O}_3, 3\text{SO}_3$, containing 68.023 per cent of alumina. Debray (*loc. sup. cit.*); Marchaud, *Erd. Journ. Prakt. Chem.*, 32, 506.
8. $2\text{Al}_2\text{O}_3, \text{SO}_3$, containing 71.851 per cent of alumina. Phillips, "Annals of Philosophy," iv., 260; Steinberg, *Erd. Journ. Prakt. Chem.*, 32, 495.
9. $5\text{Al}_2\text{O}_3, 2\text{SO}_3$, containing 76.137 per cent of alumina. Marchaud (*loc. sup. cit.*); Erdmann, *Fahrbuch der Chemie und Physik*, 1831 (ii.).

An examination of the above papers is eminently satisfactory, except from the point of view suggested by the experiments in the present communication. Special mention has already been made of the most important of them where occasion for doing so occurred. In most cases one chance experiment and one single analysis are considered by the authorities here quoted as sufficient proof of the substance obtained being definite in composition, and in a great many of them the analysis of some more or less complicated mineral is alone quoted; but the fact that some formula may be tacked on to a mineral representing it as containing a certain basic salt can scarcely, in the opinion of the author of this paper, be considered as a satisfactory proof that this basic salt exists as a definite chemical compound.

Nomenclature of the Proximate Derivatives of Carbonic Acid.—A. Bernthsen.—The author proposes the following principles: The acids with the carbonyl group are to be named "carbonyl" acids; those with the thiocarbon group CS are "thiocarbon" acids; the isomers of the carbaminic and thiocarbaminic acid are to be "imido-carbon" acids; the group CONH_2 is rendered by carbamin; CSNH_2 , thiocarbamin; and $\text{C}(\text{NH})\text{NH}_2$, imido-carbamin.—*Liebig's Annalen*.

* Misquoted in "Gmelin," iii., 312, and "Watts's Dictionary of Chemistry," v., 579, as $2\text{Al}_2\text{O}_3, 3\text{SO}_3$.

NEW FILTERING APPARATUS.*

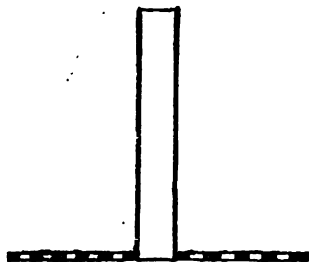
By P. CASAMAJOR.

In the year 1875,† I published descriptions of two funnels for filtering under pressure, one of which was to be applied to the method of filtration proposed by Dr. H. Carmichael, and described in Crookes's "Select Methods of Chemical Analysis," (page 429). In this method, the liquid is separated from the precipitate by the agency of a small disk of filtering paper, held against the perforated surface of a vessel, the interior of which communicates with an aspirator. This vessel, having the paper disk held against it, is placed directly in a platinum or porcelain dish, in which the precipitate is to be afterwards heated.

Dr. Carmichael made his vessel, communicating with the aspirator, of glass, but his method for making perforations on the flat side of this vessel was, to say the least, so very difficult, that very few chemists had succeeded in applying his method of filtration. The funnel which I used for the purpose was of glass, the shape being that of a Plattner's blowpipe mouth-piece. The mouth of the funnel was closed by a small disk of filter paper, resting on a perforated platinum plate. This plate was also circular and slightly smaller than the disk of filtering paper. Both the perforated plate and disk of filter paper were held tightly against the funnel by the suction of an aspirator.

In the same paper there is a description of another funnel to be used with the same filter, but, in using this

Fig. 1.



funnel, whose shape is that of a large thistle tube, the perforated platinum plate is placed on the bottom of the funnel, and, over it, the small disk of filter paper, the edges of which slightly overlap those of the perforated plate. The liquid to be filtered is poured in the funnel. With this funnel, any ordinary aspirator may be used, but I have always used, in connection with it, a simple aspirator consisting of a straight vertical tube of small diameter, attached to the bottom of the funnel. I again called attention to this particular form of aspirator in a subsequent paper,‡ published shortly after, in which are given fuller details as to its use.

The vertical tube acts by the weight of the column of water, which it holds suspended below the liquid. Its use was made possible by the fact that, when there was no more liquid above the moist disk of filter paper, this became impervious to air, and the column of liquid in the vertical tube continued to be held in suspension, but any additional liquid poured in the funnel went through the paper disk without any difficulty.

I pointed out that, instead of using a disk of filter paper, paper pulp or asbestos pulp could be poured into the funnel. The excess of water would run out, and a layer of paper or of asbestos would be left on top of the perfor-

ated plate, and around its edges, and form a very efficient filtering medium.

This aspirator, consisting of a vertical tube, was found so simple and convenient, that I tried to apply it to the funnel first described, which is used in Dr. Carmichael's system of filtration, but the experiments were not successful. In funnels of this shape, the perforated plate and disk of filter paper are held on the under side of the funnel by the suction of an aspirator. Whenever the aspirator ceases to act, the platinum plate and sheet of paper drop down.

The difficulty experienced was due to this: that the paper filter cannot be held in position unless there is a volume of liquid in the vertical tube, while, at the same time, the vertical tube cannot be filled unless the paper filter is held tightly against the funnel.

These are the antecedents of the filter and the aspirator which I now propose to describe.

In this new filtering apparatus, the filtering medium is laid on a perforated plate, provided with a tube open at both ends, which is firmly attached to the plate, over a hole of the same size as the tube. Figure 1 shows a section of the plate, with the tube attached.

This perforated plate is laid on the bottom of a dish or crucible made of platinum, porcelain, or any other suitable material. The upper portion of the tube is connected with an aspirator, and there must be a small space left between the under surface of the plate and the bottom of the vessel, to allow the filtered liquid to pass through the filtering medium. The liquid which passes into the space under the plate is removed through the tube by the action of the aspirator.

Fig. 2.

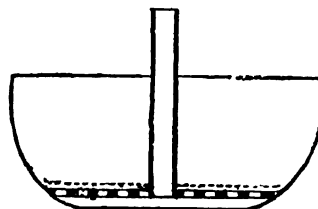


Figure 2 shows the perforated plate in position at the bottom of a platinum or porcelain dish. The filtering medium rests on top of the perforated plate, and is indicated by a fine dotted line. If the bottom of the vessel should be perfectly flat, it would be necessary to make the perforated plate slightly curved, with the concavity turned downward, to allow a space between the plate and the bottom of the vessel.

The filtering medium may be a piece of filter-paper, or it may be deposited in the form of paper pulp or asbestos pulp, as already mentioned. If a paper filter is used there should be a hole in it to let the tube go through. The perforations in the plate should begin at a certain distance from the tube, so that every portion of the perforated surface may be covered with paper.

It is a very simple matter to make this perforated plate with its tube. Any jeweller can make a tube from platinum foil and solder the joint with coin gold, which is sufficiently infusible for most purposes, and the tube can be soldered to the plate with the same material. This is the readiest way, as it is next to impossible in this country to have work of this kind done entirely of platinum.

We may also form this piece of apparatus in two portions. Any metal-spinner can turn, on a platinum plate, a tube 5 or 6 millimetres long, and, over this short tube a platinum tube about 3 centimetres long can be firmly placed. It is very important that the long platinum tube should come down as low as possible over the shorter tube, so that the pulp of paper or asbestos may be deposited over the joint.

It is almost useless to mention that the weight of the

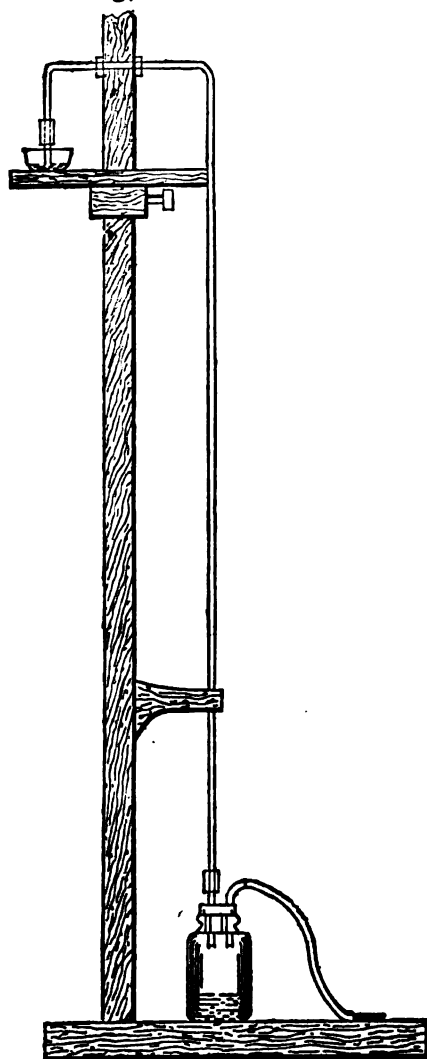
* From the *Journal of the American Chemical Society*, vol. iii.

† *American Chemist*, v., 440, and *CHEMICAL NEWS*, xxxii., 46.

‡ Funnels with auxiliary vertical tube; see *American Chemist*, vi., 124, and *CHEMICAL NEWS*, xxxii., 184.

perforated plate should be taken as part of the tare, with the weight of the platinum vessel, and of the asbestos, when a pulp of this material is used. The perforated plate remains in the crucible or dish, while the precipitate is heated, and it is afterwards placed on the balance along with the precipitate. When asbestos is used, the requisite quantity should be placed in the vessel in which the precipitate is to be heated, the perforated plate should be added, and the whole sufficiently heated. The vessel and all the contents should then be placed on the balance so as to obtain the total tare. If the platinum tube is not

Fig. 3.



soldered to the perforated plate, it may with great convenience be left out of the count, as it may be easily removed by holding down the perforated plate with a spatula, and pulling off the tubes after the filtration is over. The quantity of asbestos required is very slight. Dry asbestos, weighing 1 decigram., if sufficiently fine, can easily cover a perforated plate with a surface of 6 square centimetres (about 1 square inch.)

Very full details relating to asbestos filters may be found in an interesting paper of Mr. F. A. Gooch, read before the American Academy of Sciences, Feb. 13th, and pub-

lished in the *CHEMICAL NEWS*, vol. xxxvii., p. 181. The author does not seem to be aware that I had proposed the use of asbestos pulp in 1875, as mentioned above, by pouring the pulp over a perforated plate.

In the arrangement introduced by Mr. Gooch the filtered liquid is forced through asbestos, lying on the perforated bottom of a crucible, by the action of an aspirator. There is a tight joint formed around the crucible, by forcing it into a large rubber tube, which also fits tightly on the top of a glass funnel, in the manner proposed for porous earthenware cones by Prof. Munroe. There is no doubt that a very good aspirator for this filtering apparatus would be a straight glass tube having a small diameter, connected by a rubber tube with the stem of the glass funnel.

With the new form of filtering apparatus, having a perforated platinum plate with tube attached, any form of aspirator may be used, and there is no difficulty in using a vertical tube having a small diameter, like those already mentioned, in which the suction is caused by the weight of a column of the filtered liquid held in suspension. This aspirator with filter, shown in section, is represented in Fig. 3. The aspirator tube is bent twice at its upper end, and there terminates in a short vertical tube about 3 centimetres long, connected with the platinum tube, attached to the perforated plate by a rubber tube. The long vertical portion of this tube is connected at its lower end by a short rubber tube, with another glass tube passing through the cork of a bottle. Through the same cork passes another tube, by means of which the operator may start the liquid, and make it run into the long vertical tube.

To use this apparatus, if the perforated plate is covered with filter-paper, distilled water is poured in the platinum dish, represented in the figure, and the vertical tube is filled by sucking air from the bottle. When the tube remains filled with liquid, for even a few seconds, there is no fear of its becoming empty during the filtration. The bottle may be taken away and a beaker glass substituted. If the tube cannot be made to retain the liquid, it is best to pour some of the precipitate in the platinum dish, and this will make a sufficiently tight joint to keep the liquid in the long arm of the tube. By doing this some of the precipitate may at first be carried into the bottle, but very soon nothing but clear liquid remains in the glass tube. The glass bottle may then be taken away, and its liquid contents poured back into the platinum dish.

If instead of a sheet of paper the filtering medium is made from asbestos pulp, a certain portion of the pulp will inevitably pass through the glass tube at first. This will have to be poured back into the platinum dish, even if no portion of precipitate has gone through. If paper pulp is used, and only a small portion passes through without any of the precipitate, there is no necessity of pouring it back.

After the tube has once remained permanently filled with the filtered liquid no further difficulty will be experienced. The rest of the liquid to be filtered may be gradually poured in the platinum dish, and subsequently hot water is added to wash the precipitate.

After the operation is completed, if the platinum tube is slipped from the rubber tube which connects it with the aspirator, the water held in the platinum tube will fall back in the crucible. This is easily got rid of by subsequent evaporation, but this quantity of water, and that which remains below the platinum plate, may be mostly carried off through the aspirator by carefully removing the precipitate from a point on the edge of the paper disk, and lifting this up with the point of a needle just sufficiently to let air go in to clear the aspirator tube from liquid.

Formation-heat of Sulphocyanic Acid and of certain Sulphocyanides.—M. Joannis.—The formation-heats of the sulphocyanides are intermediate between the formation-heat of the iodides and of the corresponding bromides.—*Comptes Rendus*.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, Thursday, March 30, 1882.

Prof. H. E. Roscoe, President, in the Chair.

THE PRESIDENT, in his annual address, congratulated the Fellows on the prosperous condition of the Society. 1175 names are now enrolled on the register of the Society. 87 original communications have been made to the Society during the past session. The Treasurer's report shows a balance of £1422 of income over expenditure.

The PRESIDENT then referred to the lecture "On the Unit Weight and Mode of Constitution of Compounds," delivered by Prof. ODLING on February 2, and at somewhat greater length to the Faraday lecture "On the Modern Development of Faraday's Conception of Electricity," delivered by Prof. HELMHOLTZ on April 5. The subjects of the advancement of chemical industry and the encouragement of technical scientific instruction in this country are matters which cannot fail to be of interest to the Society. The establishment, therefore, of a Society of Chemical Industry, with its monthly journal giving the most important applications of chemistry to the numerous branches of our national industries, must be a matter of hearty congratulation. The subject of technical scientific instruction has attracted the attention of the Government, and a Commission has been appointed to investigate the subject both on the Continent and in this country. In accepting an appointment on this commission the President felt that, though obliged to be absent from several meetings, he was acting in accordance with the best interests of the Society. The Commission has already visited Yorkshire and other parts of this country, Italy, and France; Germany, Belgium, and Switzerland remain to be visited. The President has also attended the meetings of the City and Guilds of London Institute, and has been consulted upon the arrangements of the new central technical college now building at South Kensington. The President then referred to some of the most important advances made in chemistry during the past year. As regards the variation in density of the halogens at high temperatures, Crafts and Meier, also V. Meyer and Zuhlin, have shown that the molecules of gaseous chlorine are not dissociated at 1200°, but that nascent chlorine evolved from platinous chloride at the same temperature undergoes a diminution to $\frac{1}{2}\text{Cl}_2$. Two molecules of chlorine (4 vols.) are dissociated into 1 molecule occupying 2 vols., and 2 semimolecules each occupying 2 vols. The one modification therefore bears to the other the same relation as regards density as oxygen bears to ozone. The case of bromine seems to be identical with that of chlorine. Mallet has observed that hydrofluoric acid gas has at 30° a density corresponding to H_2F_2 ; at 100° its density is represented by HF. Setterberg has investigated caesium and its salts, and has prepared 40 kilos. of pure rubidium alum, and 10 kilos. of pure caesium alum. His results confirm those already obtained by Bunsen. No metallic caesium can be obtained by the carbon reduction process. Electrolysis of the cyanide was, however, successfully employed. The President also referred to the recent researches of Dr. Brauner, communicated to the Society, on the cerite metals; the discovery of a British mineral containing yttrium, by Prof. Hartley; the recent researches of Baeyer on the indigo group; the artificial production of caffeine from xanthin, by E. Fischer, &c.

Since the last Anniversary, the Society has lost two foreign members—Prof. Sainte-Claire Deville and M. V. Dessaignes, and eleven Fellows—A. E. Arnold, F. J. Barrett, E. Buckney, R. C. Clapham, R. Gerstl, J. Mackay, A. Freire Marreco, R. W. Thomas, J. S. Walton, A. Willis, and H. J. Zeld.

Prof. DEWAR moved the adoption of the Report of the

Council, and at the same time a hearty vote of thanks to the President for his able address and for the thorough manner in which he had discharged his duties during the past year.

This was seconded by Dr. HUGO MÜLLER, and carried by acclamation.

The PRESIDENT in returning thanks said that he had felt most deeply the kindness with which he had been received by every Fellow since the time that he had been elected to the distinguished position he now held. He had tried to do his best during the past, and for the future if he could do anything to further the interests of the Society, they had only to call on their past President.

The SECRETARY then read, in the absence of Dr. Russell, the Treasurer's Report.

Votes of thanks were passed to the Treasurer and the Auditors, the Officers and Council, and the Editor, Sub-editor, and Abstractors.

A ballot was then held for the election of Officers and Council. Dr. Messel and Mr. Maxwell-Lyte, the Scrutators, declared the following as duly elected, and the list was read from the Chair:—

President—Dr. J. H. Gilbert.

Vice-Presidents—F. A. Abel, Warren De la Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, H. E. Roscoe, A. W. Williamson, A. Crum-Brown, J. Dewar, P. Griess, A. V. Harcourt, J. E. Reynolds, E. Schunck.

Secretaries—W. H. Perkin, H. E. Armstrong.

Foreign Secretary—Hugo Müller.

Treasurer—W. J. Russell.

Ordinary Members of Council—E. Atkinson, W. de W. Abney, F. D. Brown, F. R. Japp, H. McLeod, G. H. Makins, E. J. Mill, C. O'Sullivan, C. Schorlemmer, J. M. Thomson, W. Thorp, T. E. Thorpe.

The Society then adjourned till April 6th.

CORRESPONDENCE.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xiv., p. 86, is a letter from Dr. J. H. Tucker, taking exception to your review of his book on sugar analysis. Your reviewer found fault with the following statement of Dr. Tucker concerning Clerget's process:—"It must be remembered that the process is entirely inapplicable when any optically active body is present, besides cane-sugar or inverted sugar, as also if the invert sugar itself exists in an inactive condition as regards polarised light."

I entirely agree with your review in finding that this passage contains erroneous opinions concerning Clerget's process, and as the subject is one of great importance in the analysis of commercial sugars and refinery products, I propose to show what Clerget's process consists in, and why it is useful in correcting errors due to optically active bodies which may be found as impurities in commercial sugars.

In a paper "On the Influence of Variations of Temperature on the Deviation of Polarised Light by Solutions of Inverted Sugar, published in the CHEMICAL NEWS (vol. xxxix., pp. 212–234), I have given very fully the theory of the correction of the direct test of the optical saccharometer by a second test after inverting the cane-sugar. I will now re-state this theory, as on it depends the understanding of the correction obtained by Clerget's process.

If we have a sugar containing (1) cane-sugar, (2) inverted sugar, (3) other optically active bodies deviating to the right, (4) other optically active bodies deviating to the left, (5) optically inactive bodies, and if the direct test in the optical saccharometer gives a deviation D, we may

state that this deviation is the *resultant* due to the algebraical sum of all the deviations caused by the optically active bodies present.

Let us call C the deviation due to the cane-sugar in the mixture, I the deviation due to invert sugar, G the deviation due to the sum of dextro-gyrate bodies in the mixture other than cane-sugar, and H the deviation due to lævo-gyrate bodies other than inverted sugar, and we may state that—

$$(1) D = C - I + G - H.$$

The only known quantity in this equation is D; the quantity we want is C. It is to Clerget that we owe the solution of this problem. By heating the solution already tested directly with hydrochloric acid the cane-sugar is entirely converted into invert sugar. After inversion, the solution is again placed in the saccharometer, and a certain deviation is observed, which is corrected for the dilution with acid, and which thus corrected we will call D'. By the action of the acid the quantity C has disappeared, and has been replaced by a certain deviation $-i$, due to the inverted sugar resulting from the cane-sugar which previously gave C. Supposing that the quantities $-I$, G, and $-H$ remain the same, we will have—

$$(2) D' = -i - I + G - H.$$

If we now subtract equation (2) from equation (1) we have

$$D - D' = C + i.$$

In this equation the required quantity C is not entirely free, but we may find it if we know the deviation to the left which is afforded by the inversion of a solution of pure sugar giving 100 to the right. Clerget found what this deviation is for every degree Centigrade, and he constructed a table by means of which we may know the value of C, when we know the value of $D - D'$, which is equal to $C + i$.

If we have a solution of pure sugar, giving a deviation to the right equal to 100, the corresponding deviation to the left after inversion is expressed by $-(44 - \frac{t}{2})$, t being the Centigrade degree of the solution of inverted sugar at the time of observation. The required quantity C is given by—

$$\frac{C}{C+i} = \frac{100}{100 + (44 - \frac{t}{2})}$$

whence—

$$C = \frac{100(C+i)}{100 + (44 - \frac{t}{2})}$$

The quantity $C+i$ is known, being equal to $D - D'$.

This is the logical base of Clerget's process. To demonstrate that the process is unreliable it must be shown that during inversion the quantities $-I$, G, and $-H$ have suffered changes, and therefore the equation—

$$D'' = -i - I + G - H$$

is not correct.

There is a possible flaw in the assumption that the quantity $-I + G - H$ remains the same after inversion. Although $-I$ does not vary, we are not perfectly sure that G and $-H$ remain unaltered. We know nothing of the bodies which, in a sample of sugar, give these quantities and their relative proportions. We must bear in mind, however, that the principal constituents of a *straight* sugar are cane and invert sugar. The other optically active bodies are present in small quantities, and the resultant of the changes produced in them must be very small, as any dextro-gyrate increase, due to some of the active substances, is likely to be compensated by lævo-gyrate increase due to others. It is possible that in syrups and other low products in which these disturbing bodies are present in larger quantities, an appreciable error may arise from the action of inversion on them. Dr. Tucker cites one thing to the point in this connection, on the excellent authority of Landolt. It is that, after inversion with hydrochloric acid, beet-sugar syrups contain optically active acids. The error resulting from this could be done away with by neutralising with carbonate of soda, as is generally done. According

to Dr. Tucker, when the bodies which accompany cane-sugar are optically inactive the correction is unnecessary. This is undoubtedly true, but to assume in a given sugar that they are so is to assume the very thing to be proved. Of course, if in equation (1) $-I + G - H = 0$, $D = C$.

Dr. Tucker also says that the unreliability of Clerget's process is shown from his own experience and the published results of others, which show that the corrected percentage is often lower than the first reading. This is due to the fact that $-I + G - H$ is a positive quantity. I have often found this to be the case, but I do not understand why the quantity $-I + H - G$ must either be equal to 0 or be a negative quantity. If any experiments have established this important point they have not been published to my knowledge.

Dr. Tucker says that one author has recommended Clerget's process in sugars containing a large proportion of commercial grape sugar, "notwithstanding that this substance is dextro-gyrate at all temperatures, and generally contains much dextrin and soluble starch, with a dextro-rotation about three times that of dextrose."

If we refer to the two formulæ $D = C - I + G - H$ and $D' = -i - I + G - H$, we may see that however large may be the quantity G, by subtracting the second equation from the first we will have $D - D' = C + i$.

It would have been more to the point to show that starch glucose and accompanying impurities have their rotary power appreciably altered by heating with one-tenth of hydrochloric acid at 60° C. for a few minutes.—I am, &c.,

P. CASAMAJOR.

Brooklyn, March 13, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 12, March 20, 1882.

Double Decompositions of the Haloid Salts of Mercury.—M. Berthelot.—In presence of the hydracids, the acid which disengages most heat unites by preference with the oxide of mercury, independent of any consideration of supposed strength, or of solubility or insolubility. This reaction is total if there is no formation of secondary compounds, acid salts, acid hydrates, or double salts, these bodies being such that their heat of formation compensates the inequality of the heats of neutralisation. On the contrary, there is distribution when the heat of formation of the secondary compounds exceeds the difference of the heats of neutralisation. The relations are regulated on the same principles in presence of alkaline salts.

Use of Superphosphates upon the Calcareous Soils of South Eastern France.—M. de Gasparin.—The author gives partial analyses of the mineral phosphates of Tavel and Figeac, both much used in the manure trade. The former of these contains 31.5 per cent of iron, calculated as sesquioxide, and the latter 42.7. A sample of superphosphate made from such materials contained 29.7 per cent of insoluble matter, only 11.71 of phosphoric anhydride, 9.7 per cent ferric oxide, and 3.2 alumina in a soluble state.

New Compounds of Nitric Acid and Acetic Acid with Ammonia.—L. Troost.—In former papers (*Comptes Rendus*, lxxviii., pp. 578 and 1267, and xcii., p. 715), the author has described the compounds of dry ammonia with the hydracids. He now shows that it combines also in several proportions with the oxacids. The first of these compounds here described contains 5 equivs. ammoniacal

gas to 2 equivs. of nitric acid. This ammoniacal nitrate is solid at temperatures below -22° . The formula of this body is $\text{NO}_3\text{HO}, \text{NH}_3 + \frac{1}{2}\text{NH}_3$. In addition there seems to be another nitrate of the probable formula of—



The author has also obtained two acetates.

Observations on M. Violle's Recent Note on the Boiling-heat of Zinc.—L. Troost.—The author states that the results obtained by Sainte-Claire Deville and himself differed very little from those published by M. E. Becquerel.

Action of Acid Solutions upon Stannous Oxide.—A. Ditte.—Stannous hydrate may lose its water and become transformed into crystals of the anhydrous oxide under circumstances which are complex and imperfectly known. The crystallisation may occur either in acid or alkaline liquids. The author examines the first case in detail, and shows that with reference to oxide of tin the acids may be divided into two groups. Those of the one group give, with this oxide, salts which are entirely decomposed by boiling water, and determine its transformation into the crystalline oxide in consequence of successive reactions. These salts, decomposable by water, yield free acid, and behave absolutely like the acids themselves, determining the crystallisation of stannous oxide. The acids of the second class do not give rise to these successive reactions, and the hydrated stannous oxide never becomes anhydrous and crystalline under their influence.

Action of Ozone upon the Salts of Manganese.—M. Maquenne.—Ozone readily determines the transformation of manganous oxide into permanganic acid in conformity with thermic theory.

Clarification of Must destined for the Manufacture of Champagne.—F. Jean.—Not suitable for abstraction.

Nuts of Kola, Gourou, or Ombene.—E. Heckel and F. Schlagdenhauffen.—These nuts are the fruit of *Sterculia acuminata*, an African tree. They are richer in caffeine than the best coffee, not combined with an organic acid, but free. They also contain a very appreciable quantity of theobromine, besides grape-sugar, and starch. There is but little fatty matter.

Crystalline Forms of Zirconia, and the Conclusions to be drawn for its Qualitative Determination.—A. M. Levy and L. Bourgeois.—This paper requires the accompanying diagrams.

Moniteur Scientifique, Quesneville.
January, 1882.

Diastase of Koji.—R. W. Atkinson.—From the *Proceedings of the Royal Society*.

Alkaloids having a Mydriatic Action.—A. Ladenburg.—The substance of this memoir has already appeared in the *CHEMICAL NEWS*.

Industrial Society of Mulhouse.—Meeting of Nov. 9, 1881.—Papers were read on the action of an alkaline solution of potassium ferricyanide upon aniline hydrochlorate, by M. Wagner; on the applications of tannin in dyeing and printing, by M. J. Kœchlin; and on the manufacture of potassium sulphocyanides and ferrocyanide, by Uri de Gunzburg and J. Tscherniac.

Patents Concerning the Manufacture of Artificial Colouring-Matters.—Abridged specifications of fourteen patents.

Trichinæ and their Distribution.—From the *Journal of Science*.

Composition of Elephant's Milk.—Dr. C. Doremus.—From the *Journal of Applied Science*.

The Last Discoveries of F. Selmi.—A. Vernon.—In a letter to M. G. Ercolani, the late Prof. Selmi speaks of a saccharifying agent contained in the white of egg. This is the more important as the yolk contains starch.

Risks of Fire in the Use of the Electric Light and on Preventive Measures.—Dr. H. Morton.—From the *Sanitary Engineer*.

Production of Manures in Distilleries.—L. Faucheux.—The author shows that much plant-food in the shape of potassium salts, ammoniacal and other nitrogenous matter, and phosphoric acid is often run to waste in the refuse of distilleries.

Commercial Aluminium Sulphate.—M. Debray.—From the *Journal de la Soc. d'Encouragement*.

Rice Paper.—From the *Journal of Applied Science*.

Analysis of Soaps.—C. Hope.—From the *CHEMICAL NEWS*.

Manufacture of Gas from Castor Oils.—From the *Journal of Gas Lighting*.

Purification of Ill-flavoured Alcohol.—M. Naudin.—The author proposes the use of hydrogenising agents.

Manufacture of Maltose.—M. Dubrunfaut.—The author considers the probable bearings of this new manufacture upon agriculture and upon beet-root sugar.

A New Alkaloid extracted from the Cinchona Bark.—D. Howard and J. Hodgkin.—From the *Journal of the Chemical Society*.

Determination of Aceton in Commercial Wood-Spirit.—M. Kramer.—Into a test-tube holding 50 c.c. are poured 10 c.c. of a binormal solution of soda to 1 c.c. of the sample under examination. There are then introduced 5 c.c. of a binormal solution of iodine, and the mixture is shaken. The precipitate of iodoform is dissolved in 10 c.c. of ether and 5 c.c. of the ethereal solution are evaporated in a tared watch-glass. The residue represents iodoform, which is calculated as aceton. Wood-spirit used in the manufacture of aniline colours should not contain more than 1 per cent of aceton.

Preparation of Aluminium.—Aluminium sulphide is obtained from powdered cryolite, and it is then decomposed by heating to redness with iron turnings. The cryolite is first dissolved in water, which dissolves out the sodium fluoride. The residue, aluminium fluoride, is calcined with calcium sulphide, the results being aluminium sulphide and calcium fluoride.

Justus Liebig's Annalen der Chemi,
Band 211, Heft 1.

Hypophosphoric Acid.—T. Salzer.—The author's former conjecture that hypophosphoric acid is identical with the ultimate product of the spontaneous oxidation of phosphorus is not confirmed. The hypophosphates and their solutions are permanent, though the free acid undergoes a gradual change on concentration with the formation of pyrophosphoric acid. The preparation of the acid and the properties of its salts are described at length. The determination of hypophosphoric acid is effected by titration with potassium permanganate. The operation is performed at a gentle boil; the sulphuric acid used for acidification must be free from nitrogen compounds, and from any impurity which might decompose permanganate; the titration must be begun at once after adding the sulphuric acid, and must be completed as quickly as possible. The addition of large quantities of water must be avoided unless freed from dissolved oxygen by boiling for at least an hour.

Origin and Constitution of β -Naphthoquinon and some of its Derivatives.—C. Liebermann and P. Jacobson.—The authors treat of the formation of β -naphthoquinon from β -naphthylamine; the preparation of β - and α -naphthoquinon by means of the azo-compounds; the constitution of β -naphthoquinon and of the anilides of the naphthoquinones.

Preparation of the Rubidium and Cæsium Compounds, and the Isolation of the Metals.—Dr. Car Setterberg.—Already noticed.

Suberon.—Dr. A. Spiegel.—The author gives an account of oxysuberanic acid, chloro-suberonic acid, suberen, and suberan-carbonic acids.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 5, 1882.

Pezzer's Accumulator.—This battery is constructed as follows:—Narrow bands of lead, 10 to 15 millimetres broad and 500 in length, are obtained by cutting up sheets of a suitable thickness, and they are made to take a waved form by being passed between the rollers of a machine used for folding stuffs obliquely. Each of them is doubled in two, and they are placed in juxtaposition, fold upon fold. The free ends are then soldered together by the autogenous process, forming them into fringes. These fringes are introduced in place of the carbon and the zinc in a Bunsen element (Ruhmkorff's model), where some of them fill the porous vessel, and the others the interval between the porous vessel and the sides of the exterior vessel. The soldered ends are upwards and the folds downwards. Plates soldered to the upper part serve as electrodes.

Journal de Pharmacie et de Chimie.
January, 1882.

Chemical and Physiological Researches on the Ordeal Poison of the Gabonese.—E. Heckel and F. Schlagdenhauffen.—The plant in question, M'Boundou, contains strychnine. No other alkaloid is present.

A Molecular Compound of Camphor and Aldehyd.—P. Cazeneuve.—Already noticed.

Mercury Salicylates.—H. Lajoux and A. Grandval.—The neutral mercuric salicylate is insoluble in water, ether, and alcohol, but soluble in solutions of common salt. The mercury is completely masked, and gives no reaction even with sulphuretted hydrogen. To show its presence in the moist way the salicylate must be heated gently with sulphuric acid till it becomes flesh coloured. All then dissolves, and the liquid becomes colourless. The mercury can then be detected in the liquid by the ordinary reagents. The author describes also a normal salt, which is less stable than the neutral salicylate, and also a neutral and a normal salicylate.

MEETINGS FOR THE WEEK.

TUESDAY, 11th.—Institute of Civil Engineers, 8.
— Royal Medical and Chirurgical, 8.30.
— Photographic, 8.
WEDNESDAY, 12th.—Microscopical, 8.
FRIDAY, 14th.—Astronomical, 8.
— Quett Microscopical Club, 8.

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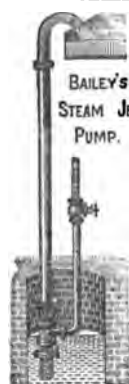
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THE CHEMICAL NEWS

VOL. XLV. No. 468

24 APR 82

ON THE SPECTRUM OF CARBON.

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and
J. DEWAR, M.A., F.R.S., Jacksonian Professor,
University of Cambridge.

THE spectroscopic investigations we have communicated to the Society "On the Reversals of the Lines of Metallic Vapours" have shown the importance of a thorough and accurate knowledge of the ultra-violet spectra of the elements, for it is in the lines of short wave-length as a rule that the greatest emissive power is manifested, and they are therefore most readily reversed. Thus we have succeeded in reversing upwards of a hundred lines in the ultra-violet spectrum of iron (*Proc. Roy. Soc.*, vol. xxxii., p. 404). The necessity for accurate data in regard to this region of the spectrum led us to make a long study of the spectrum of magnesium, and the results of this investigation appeared in the volume of the *Proc. Roy. Soc.* just cited. Having had occasion to examine the origin of the different fluted spectra of carbon, it became apparent that a complete knowledge of the relations of these spectra to the simple spectrum of the element could only be reached by the help of a complete record of the line spectrum. Angström and Thalén, in their memoir "On the Spectra of the Metalloids" (*Nova Acta Reg. Soc. Upsal.*, Ser. 3, vol. ix.), give a map and table of wave-lengths of the lines due to carbon in the visible part of the spectrum, as distinguished from the fluted spectra given by compounds of carbon,—namely, carbonic oxide, cyanogen, and acetylene. These lines, they state, always appeared when very powerful induction sparks were passed through the vapour of any compound of carbon, or between carbon electrodes. This line spectrum is remarkable for simplicity, consisting of eleven lines, of which the single line in the yellow, followed by a triple group in the green, and a very strong line in the blue, recall vividly the spectrum of magnesium; and as we know two modifications of the spectrum of magnesium which seem to be due respectively to the oxide and a hydride, the parallel between the behaviour of the two elements is the more striking. The plates of the ultra-violet spectra of the metals by the late Prof. W. A. Miller (*Phil. Trans.*, 1864) include plates of the spark taken between metallic electrodes in different compounds of carbon, which show with sufficient clearness that there are some five groups of lines in the ultra-violet spectrum of this element. In the observations here described we have preferred taking intense induction sparks between pure graphite poles in different gases.

A figure accompanying the paper represents the ultra-violet spectrum of carbon to a scale of wave-lengths within the range of the rays transmitted through calcite. The lines figured have been observed in photographs of the spark of a large induction coil, having a large Leyden jar in connection with the secondary coil, between poles of purified graphite in air, carbonic acid gas, hydrogen, and coal-gas. The same lines have been observed in photographs of the spark between iron, and between aluminium poles in carbonic acid gas. By comparing the photographs taken under these different circumstances, we have, we believe, eliminated the air lines, which are numerous and strong in the region between H and T, and will form the subject of a future communication, and also the metallic lines which graphite, purified with the utmost care, still exhibited.

The graphite was purified by being stirred in fine pow-

der into fused potash, and subsequent treatment with aqua regia, by prolonged ignition in a current of chlorine, and by treatment with hydrofluoric acid. The well-washed powder was afterwards compressed into blocks by hydraulic pressure between platinum plates, and from these blocks the electrodes employed were cut. Notwithstanding the purification the photographs of the spark between these electrodes still showed very distinctly lines of magnesium and iron. This fact shows the extreme difficulty of getting rid of all impurity, and the caution which is requisite in any reasoning depending on the assumption of chemical purity in the materials employed. It is very possible that the magnesium and even the iron in this case may have been due to oxides of those metals in the floating dust of the laboratory, which we know always contains sodium compounds, and which at Cambridge—where the water, soil, and bricks contain sensible quantities of lithium—almost always show traces of that element.

The wave-lengths of the strongest carbon lines were determined by means of a Rutherford diffraction grating having 17,296 lines to the inch. The measures were made in the following way:—The collimator and telescope of the goniometer were first centred by the instrument maker's marks. The telescope was then more carefully adjusted for centre by directing it on to a distant mark, taking the reading of the circle, turning the arm carrying the telescope through 180° and reversing the telescope, whereby the mark was again brought into the field of view, and adjustments were then made until the mark had the same position on the cross-wires in both positions of the telescope. The grating was next placed in position, and, after adjustment to the vertical plane, was brought very nearly at right angles to the axis of the collimator by turning it until the sodium D lines in the spectra of the second order were observed to fall at equal distances on either side of the collimator. The small photographic slide, containing the sensitive plate, fitted the telescope in place of the eye-piece, and so could easily be turned about an axis coincident, or nearly so, with the optic axis of the telescope. In taking a measurement of the position of a line the approximate wave-length was first found by interpolating between the nearest cadmium or other lines of known wave-length in photographs taken with calcite prisms. The telescope was then set to the angle corresponding to this approximate wave-length for the spectrum of the fourth order. The lower half of the slit was closed by a shutter, and, the photographic slide having been adjusted for level, the plate was exposed to the light which came through the upper half of the slit, and gave an image of the lines in the lower half of the field. When this exposure was completed the photographic slide was turned round through 180° about the axis of the telescope, so as to bring to the top that part of the sensitive plate which had been before lowest. It was then exposed a second time, and thus two images of the same line were impressed on the plate, which were necessarily at equal distances on either side of the point where the axis of the telescope met the plate. By a subsequent measurement with a micrometer under a microscope of the distance between the two images, and the conversion of this distance into angular measure, a connection was found, which was added to or subtracted from the reading of the circle to get the exact deviation of the ray producing the line under observation. Another photograph of the same line was next taken in the same way as before, except that the telescope was placed at the corresponding angle on the other side of the collimator. From the two angles thus found the wave-length of the line was calculated. The process was repeated three or four times for each line, and the mean wave-length thus found for carbon lines were 2297'4, 2478'4, 2508'7, 2511'6, 2836'3, and 2837'3. The numbers deduced from the different photographs of the same line differed from one another in the last figure only, so that we are justified in assuming the first four figures to be accurate in each case. The wave-lengths of the remaining lines were obtained by interpolation from mea-

* Abstract of a Paper read before the Royal Society, March 9th, 1882.

tures of photographs taken with a train of two calcite prisms of 30° each, and one of 60°, on which the iron as well as the carbon lines were shown. The wave-lengths of the iron line used in the interpolations were deduced from photographs taken with the grating in the same way as that above described for the carbon-lines. The wave-lengths thus formed for the remaining carbon lines are given in the table below.

In taking the photographs of the spark the induction coil was sometimes worked by a De Meritens dynamo-electric machine, and in that case the stream of sparks was not only extremely brilliant, but produced a deafening roar. Notwithstanding this character of the spark, the photographs, when the spark was taken in air, between poles of purified graphite, showed, besides the carbon lines above described, the set of six cyanogen flutings in the blue very distinctly, and those between K and L, and those near N, strongly developed. On the other hand, when the spark was taken in carbonic acid gas, these flutings almost entirely disappeared, and would no doubt have disappeared entirely if the last traces of air had been removed from the apparatus.

TABLE OF CARBON LINES.

Authors.	Colour.	Wave-length.	Intensity.
Ångström and Thalén.	Red ..	6583.0	2
		6577.5	1
		5694.1	4
	Orange	5660.9	4
		5646.5	3
		5638.6	5
	Yellow	5379.0	6
		5150.5	4
		5144.2	3
	Green	5133.0	5
		4266.0	1, diffuse
	Indigo	2995.0	4, very diffuse
		2968.0	5, " "
		2837.3	" "
		2836.3	2
		2746.5	3, very diffuse
		2733.2	6, " "
		2640.7	4, " "
		2541.5	6
		2528.2	5
		2523.6	5
		2518.7	5
		2515.8	4
		2514.0	5
		2511.6	2
Living and Dewar.	Ultra- Violet	2508.7	3
		2506.6	5
		2478.4	1
		2297.4	3
		3919.3	2, diffuse
		3876.5	4, " "

Spectrum of Incandescent Carbon Filaments.

We have also examined the spectrum of Swan's incandescent lamps. So long as the carbon thread is unbroken it emits a continuous spectrum, on which neither bright nor dark lines are visible. By gradually increasing the number of cells in the battery, until the thread gave way, we found at the instant of fracture, for a small fraction of a second only, that a set of flutings in the green appeared. In some of those lamps we observed, when the current was nearly as much as the carbon thread would bear without rupture, that a sort of flame appeared in the lamp. On examining the spectrum of this flame it gave the flutings of carbonic oxide very distinctly, and we made sure that they were those of carbonic oxide, and not those of hydrocarbons, by comparison with the bands of a Bunsen burner. Closer examination showed that this flame was strongest about the junction of the carbon thread with one of the conducting wires, and that on reversing the current it

shifted from one wire to the other, and the wire about which it appeared was always the positive electrode. In fact the flame was the glow of the positive pole attending a discharge of rarefied gas: when the resistance of the carbon thread became too great in proportion to the intensity of the current, the discharge began to occur through the rarefied atmosphere within the envelope of the lamp. The spectrum showed that this atmosphere contained carbonic oxide.

By interposing different flames between the incandescent lamp and the slit of the spectroscopic we have been able to make some comparisons of the probable temperatures of the flames and filament. For this purpose a lens of 3 inches focal length was placed 6 inches in front of the slit, and an image of a horizontal part of the incandescent carbon thread formed by it across the (vertical) slit. The appearance in the field of view of the spectroscopic was a narrow continuous spectrum extending all across the field. When a flame was interposed between the lens and the slit, the bright lines of the flame were seen above and below the narrow continuous spectrum, and in some cases were continued across it or were seen reversed upon it. When the flame was that of a Bunsen burner in which was a platinum wire with sodium carbonate, the yellow sodium lines were seen bright above and below the continuous spectrum of the carbon thread, but reversed where they crossed it. When lithium was substituted for sodium in the flame, the red lithium line was also seen bright above and below the continuous spectrum, but reversed where they crossed it. When an oxyhydrogen jet was substituted for the Bunsen burner, and sodium carbonate held in it, the yellow sodium lines were not only bright above and below the continuous spectrum of the carbon, but showed as bright lines where they crossed it; in fact they were conspicuously brighter than the carbon. When coal-gas was substituted for hydrogen in the jet the same appearance presented itself, only the sodium lines were not so much brighter than the carbon as they were before. Fifty Grove's cells were used with the incandescent lamp, which were as many as could be used without danger of rupturing the threads. When barium chloride was held in the hydrogen flame fed with only a little oxygen, the bright green line of barium (wave-length 5534) was well seen above and below the continuous spectrum, but could not be traced either bright or dark across it. When a flame of cyanogen burning in air was interposed, the bright bands of that flame could be seen above and below the continuous spectrum, but could not be traced either bright or dark across it. When sodium carbonate was held in this flame the yellow sodium lines were seen feebly reversed where they crossed the spectrum of the incandescent lamp. We infer from these experiments that the emissive power of the carbon thread for light of the refrangibility of the D lines is nearly balanced by that of sodium at the temperature of the flame of cyanogen burning in air, but is sensibly less than that of sodium at the temperature of a jet of coal-gas and oxygen, much less than that of sodium in the oxyhydrogen jet. This seems to render it probable that the temperature of the incandescent thread is not far different from that of a cyanogen flame burning in air, but is less than that of an oxyhydrogen flame, though this does not necessarily follow from the experiments, inasmuch as the radiation of the sodium is so much more limited as to range than that of the carbon. When a Bunsen burner or a gas blowpipe flame was interposed between the lens and slit, no reversal of the hydrocarbon bands could be seen. When magnesium was burnt between the lens and slit, the magnesium lines (b) were seen bright, eclipsing the carbon. Possibly the smoke of magnesia may have considerably helped to eclipse the light of the carbon.

Action of Cyanogen on Sodic Menthol.—G. Arth.—The author has obtained a compound agreeing in its composition with a menthol-urethane.—*Comptes Rendus*.

ACTION OF ETHYLENE CHLORHYDRIN UPON
THE BASES OF THE PYRIDINE SERIES
AND ON QUINOLINE.*

By Professor ADOLPH WURTZ, For. Mem. R.S.

ACCORDING to the constitution which is generally attributed to the bases of the pyridine series, they must be considered as tertiary bases, their nitrogen being united to the carbon by three atomicities. The action which alcoholic iodides exert upon these bases, as shown by Hofmann, confirms this idea, which is equally applicable to quinoline. I thought that the reaction of glycol chlorhydrin and similar compounds upon the pyridine bases and upon quinoline should produce oxygenated quaternary bases. It is known, in fact, that such a base, neurine, results from the action of ethylene chlorhydrin upon trimethylamine. The beautiful results which Ladenburg obtained recently by the reaction of chlorhydrin upon secondary bases are well known. He is still continuing these researches to the great profit of science. I myself, entering again on a line of researches which I had formally traced, will describe the results obtained by investigations undertaken in the direction indicated with the pyridine bases and quinoline.

I had two specimens of collidine at my disposal, presenting the same boiling-point. One obtained by the distillation of aldol-ammonia was undoubtedly identical with aldehydine of Baeyer and Ador (boiling-point 179—182° C.), the other was isolated from the pyridine bases formed by the distillation of cinchonine with hydrate of potassium; this collidine is the α -collidine (boiling-point 179—183°).† The experiments have proved that these two collidines are isomeric.

Action of Ethylene Chlorhydrin upon Aldehydine.

A mixture of these two compounds, in proportion of their molecular weights, to which a quantity of water weighing as much as the aldehydine employed is added, is heated during several days in closed tubes to 100° C. The oily layer which floated on the mixture at the end of the operation continually decreased and finally disappeared after cooling. The aqueous liquid, which was slightly brown, was extracted with ether, and finally evaporated in the vacuum. The ether had dissolved a small quantity of unattacked aldehydine and chlorhydrin. The chlorhydrate, concentrated by evaporation, was mixed with an excess of platinum chloride, and alcohol was added to the mixture. An abundant crystalline precipitate was obtained, and was purified by several crystallisations in hot water. In this manner magnificent voluminous orange-red crystals of chloroplatinate of oxethyl-aldehydine were obtained. Their analyses furnished the following numbers:—

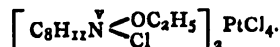
	Experiment.			Theory.
	I.	II.	III.	
Carbon ..	32.65	32.80	31.90	32.33
Hydrogen ..	4.46	4.45	4.53	4.31
Nitrogen ..	4.10	4.22	"	3.77
Chlorine ..	28.24	"	"	28.70
Platinum ..	26.30	"	25.84	26.27

The Analysis III., which is the most accurate, was executed with a salt which had been dried in the vacuum; when this salt is heated to 100° C. it loses hydrochloric acid, which tends to augment the proportion of carbon and of platinum. The Specimen III., after having been heated to 100° during some time, contains 28.2 per cent of platinum. This alteration, which is more marked in the case of the chloroplatinate of oxethyl-collidine, will be examined later on. The results of these analyses lead to the

* A Paper read before the Royal Society, March 30, 1882.

† The β -collidine which Mr. Oechsner de Coninck found amongst the cinchonine bases boils at 198°.

formula $(C_{10}H_{16}NOCl)_2PtCl_4$, which is that of a chloroplatinate of oxethyl-aldehydine:—



This chloroplatinate forms magnificent orange-red crystals of clinorhombic aspect. It is quite soluble in hot water, and the concentrated boiling solution, when it cools becomes cloudy, by depositing oily drops which finally transform themselves into crystals. Decomposed in aqueous solutions by sulphuretted hydrogen, it furnishes a chloride whose solution is colourless, and does not crystallise after being evaporated during several days in the vacuum. Decomposed by oxide of silver and water it furnishes a caustic soluble base, which attracts the carbonic acid of the air.

These reactions permit no doubt as to the character of the new base, which is a sort of aldehydine neurine.

Action of the Ethylene Chlorhydrin upon α -Collidine.

In order to obtain the α -collidine quaternary base corresponding to neurine the method just indicated was employed. The reaction is, however, more rapid than in the previous case; and after heating for a few hours the oily layer disappears, excepting a few black drops which still float on the liquid. The liquid is extracted with ether, evaporated in the vacuum, and finally treated by platinum chloride, furnishes a crystalline orange-yellow precipitate less soluble in water, and much less stable than the preceding one. The analyses of this salt, dried over sulphuric acid, gave the following results:—

	Experiment.		Theory
	I.	II.	
Carbon ..	31.23	—	32.23
Hydrogen ..	4.16	—	4.32
Platinum ..	26.32	26.16	26.48

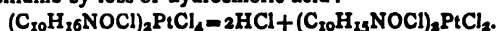
The solution of this salt in hot water becomes of a deeper brown-red colour the more concentrated it becomes. On boiling it decomposes. Its solution in a large quantity of hot water, on cooling, deposits orange-red crystals tinged with brown. These crystals give the following numbers when analysed:—

	Experiment.			Theory.
	I.	II.	III.	
		Orange crystals from the mother-liquor.		
Carbon ..	30.39	—	31.56	32.23
Hydrogen ..	4.09	—	4.18	4.31
Platinum ..	27.48	27.02	26.33	26.48

These crystals do not possess exactly the composition of the chloroplatinate $(C_{10}H_{16}NOCl)_2PtCl_4$, which must therefore be altered by the action of boiling water. In fact, the solution became deeply coloured after several minutes boiling,* and on being decomposed by sulphuretted hydrogen, furnished a solution which, after being evaporated on the water-bath and filtered, showed a brown tint, and gave after several days brownish-red crystals. These were purified by crystallisation from boiling alcohol, in which they are very slightly soluble. By the cooling of the solution a salt was obtained, which crystallises in brilliant scales, possessing a brownish tint, and corresponding exactly to the formula of a chloroplatinate of oxethyl- α -collidine, $C_{10}H_{15}(PtCl)NOCl$.

		Theory.
Carbon ..	35.61	35.84
Hydrogen ..	4.79	4.42
Chlorine ..	20.89	21.30
Platinum ..	29.30	29.42

This salt is derived from the chloroplatinate of oxethyl- α -collidine by loss of hydrochloric acid:—



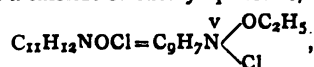
* In one experiment an elimination of a small quantity of platinum which blackened the liquid was noticed.

The crude chloride of oxethyl- α -collidine, or the chloride separated from the unaltered chloroplatinate by sulphuretted hydrogen, treated with chloride of gold, furnishes an abundant precipitate, which condenses directly into dark yellow drops.* These drops soon transform themselves into crystals, which melt under hot water, but are soluble in a large quantity of boiling water. The solution, when cooled, deposits first yellow drops, then magnificent thin needles of golden yellow colour. They are the chloroaurate of oxethyl- α -collidine, $C_{10}H_{16}NOCl.AuCl_3$.

		Theory.
Carbon	23.79	23.79
Hydrogen	3.35	3.17
Nitrogen	—	—
Gold	38.96	38.91

Action of Ethylene Chlorhydrin upon Quinoline.

The quinoline which was employed in this experiment was obtained by distilling cinchonine with hydrate of potassium, and possessed, after a great number of rectifications, the boiling-point 238° to 240° C. The quinoline was heated with an equivalent quantity† of glycol chlorhydrin, to which its weight of water had been added. After three days' heating the oily layer had entirely disappeared. The mixture was cooled and extracted with ether, and the aqueous solution, slightly coloured brown, was concentrated. After a few days the solution contained a great amount of brown crystals, which were strongly pressed between layers of paper, and finally dissolved in absolute alcohol. The solution was treated with animal charcoal, filtered boiling, and, after cooling, anhydrous ether was added, so as to float on the alcoholic layer. The next day the alcoholic solution was filled with magnificent colourless prisms, some of which traversed the entire vessel. This salt is a chloride of oxethyl-quinoline,—



formed by the addition of glycol chlorhydrin to quinoline.

		Theory.
Carbon	63.20	63.01
Hydrogen	5.96	5.72
Nitrogen	6.83	6.68
Chlorine	16.29	17.42

This chlorhydrate has a bitter taste, attracts the atmospheric moisture, and is very soluble in water and in alcohol, insoluble in ether. Its aqueous solution is not precipitated by ammonia, and gives with potassa a thick coloured precipitate. Boiled for several seconds with oxide of silver, the solution forms chloride of silver and reduced silver, and the filtered liquid possesses a very strong alkaline reaction, and rapidly assumes a crimson tint. The hydrate of plumbic oxide decomposes this chloride in a similar manner. Corrosive sublimate forms with it a compound which crystallises easily.

Chloride of gold produces, in the solution of this chloride, a yellow precipitate, soluble in boiling water, from which it crystallises on cooling in small crystals, which appear under the microscope as pointed lozenges. This chloroaurate possesses the formula—



		Theory.
Carbon	26.21	25.77
Hydrogen	2.94	2.34
Gold	37.98	38.30

Platinum chloride forms a chamois-yellow precipitate in the solution of the chloride. This precipitate is soluble in a large quantity of boiling water, and crystallises from the cold solution in small opaque orange crystals, of the formula $(C_{11}H_{12}NOCl)_2PtCl_4$.

* With the crude chloride a dark colouration, due to a reduction of the gold salt by some impurity, is observed.

† 16 gra. of quinoline for 10 gra. of chlorhydrin.

	Experiment.			Theory.
	I.	II.	III.	
Carbon	35.03	34.54	35.09	34.82
Hydrogen	3.41	3.35	3.35	3.16
Nitrogen	3.70	"	"	3.70
Chlorine	"	"	27.4	28.09
Platinum	26.09	26.8	26.9	26.0

The specimen I. was the pulverulent yellowish chloroplatinate, simply precipitated and dried in the vacuum. The others had been dissolved in boiling water, and were thereby slightly altered, as the excess of platinum proves. When quinoline is heated with an equivalent quantity of ethylene chlorhydrin without adding water, a dark purple-reddish mass is obtained. Extracted with ether, dried, and treated with absolute alcohol, this mass gives a dark violet solution, which, if ether is poured on it, deposits an almost black mass, which finally crystallises. The crystals, pressed between sheets of paper, are sensibly less coloured than the mother-liquor, which imparts to the paper a dark violet colour.

I have not yet concluded the analysis of this product, and I propose to continue these researches in various directions.

MINERAL WATER FROM AMHERST, BRITISH BURMAH.

By R. ROMANIS, D.Sc., Government Analyst.

A MINERAL spring having been discovered in the Amherst district, which is attracting great crowds by the wonderful cures reputed to be performed by its waters, the authorities forwarded a few gallons for analysis. The following is the composition in parts per million:—

Carbonate of lime	1092.6
" " potash	57.8
" " soda	27.0
" " magnesia	23.2
Silicate of lime	31.1
Alumina and oxide of iron	12.8
	1244.6

POTASH FROM BAMBOO.

By R. ROMANIS, D.Sc., Government Analyst.

It has been proposed by the Forest Department of British Burmah to extract potash from the ashes of the shoots of the bamboo. A sample forwarded to the laboratory for analysis gave the following results:—

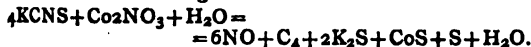
K_2O	32.54
Na_2O	0.98
KCl	18.72
SiO_2	16.95
CO_2	8.07
SO_3	2.71
Fe_2O_3	1.10
Al_2O_3	19.43
H_2O	100.50

Detection of Logwood in Wine.—Twenty c.c. of the wine are shaken up with 2 grms. manganese peroxide and filtered. The liquid produced, which is brown even if no logwood is present, is treated with zinc and hydrochloric acid. The humic compounds are thus re-converted into hæmatoxylin, which may be detected by the usual reagents.—*Giornale Farm. Chim.*

A MODE OF PREPARING NITRIC OXIDE, NO.

By D. EWART JOHNSTONE.

Heat gently in an ordinary retort or flask, about 4 parts of the potassium sulphocyanide solution (usually kept for analytical purposes in laboratories) with 1 part of solution of cobaltous nitrate. Nitric oxide comes off very readily and in large quantities. Instead of the solutions the above-mentioned salts in the solid form, slightly moistened with water, are equally effective. The equation is somewhat like the following:—



Sandringham School Laboratory,
Southport.

NOTE ON THE ESTIMATION OF
NITRIC AND NITROUS NITROGEN IN THE
STATE OF AMMONIA.

By ANTONY GUYARD HUGO TAMM.

THE writer endeavoured and succeeded in estimating in the state of ammonia, nitrogen in all its oxidised forms, in the apparatus and by the processes devised by Messrs. Péligot, Will, and Varrentrapp, which have rendered such services to science and technology on account of the simplicity of the manipulation and the accuracy of the results.

The writer has solved this important problem by means of the following process, founded on a hitherto unsuspected reaction, and he firmly believes that it will prove of immense advantage to organic and agricultural chemistry, and that it will hereafter be used almost exclusively for the estimation of nitrogen in gunpowder, fulminating substances, explosives, &c.

This new process is founded on the fact that in presence of marsh gas and soda lime at a red heat, all the acids and oxides of nitrogen, either free or combined to bases or to organic compounds, are *totally* converted into ammonia.

The *modus operandi* adopted by the author is the following:—

75 grs. of dry acetate of soda are intimately mixed with 1½ ozs. of soda lime, and the fifth or fourth part of the mixture is introduced at the sealed end of the combustion tube. This portion of the mixture is intended ultimately to free the tube of its ammoniacal contents by means of the stream of marsh-gas which it produces. The remainder of the mixture of soda lime and acetate of soda is thoroughly mixed with from 5 to 7 grs. of the nitric compound (saltpetre, gun-cotton, gunpowder, fertiliser, &c.); the whole is introduced in the tube, which is finally filled with a column of *ordinary* granulated soda lime, and the operation is then conducted *exactly* as it would be in an ordinary estimation of ammonia or ammoniacal nitrogen.

This mode of estimation, which is *absolutely* accurate, as can easily be proved by estimation of nitrogen in well-known substances which can be obtained in the greatest state of purity—fused nitrate of potash, nitrite of silver, &c., is the only process by which the total amount of nitrogen existing under various forms can be estimated in the state of ammonia in a single operation; hence its great practical value.

However, in order to determine nitrogen in its various forms in the same substance, nitrogen in the state of ammonia or cyanogen, nitrogen in the state of nitrate, nitrogen in the state of nitrites, three operations are needed:—

1. Estimation of ammoniacal nitrogen by means of soda lime and oxalate of lime.

2. Estimation of total nitrogen by means of the mixture

soda lime and acetate of soda. The difference between these two determinations giving ammoniacal nitrogen and total nitric or oxidised nitrogen.

3. Estimation of total nitrogen by means of the mixture soda lime and acetate of soda on a portion of the substance previously dried over a water-bath with excess of acetic acid in order to eliminate nitrous acid. The difference between total nitric nitrogen estimated in 2, and nitric nitrogen estimated in 3, gives nitrous nitrogen.

Such estimations as the preceding are especially useful in the examination of residues of mineral waters, and of manures, fertilisers, and earths.

The writer was so pleased at the results obtained by the new process that he immediately gave up a series of researches having the same object (namely, the estimation of nitric nitrogen in the apparatus and by the processes devised by Péligot, Will, and Varrentrapp) by means of mixtures such as soda lime and almost dry proto-sulphate of iron, or soda lime and sulphide of sodium lime (obtained by slaking quicklime in sulphide of sodium). In both these cases, and at a red heat, a considerable proportion of the nitrogen of nitric and nitrous acids and oxides was converted into ammonia, and the writer would certainly have succeeded in applying these reactions to analysis had not the marsh-gas and alkali process superseded every other.

THE QUANTITATIVE SEPARATION OF ROSIN
FROM FATS.*

By THOMAS S. GLADDING.

THE need of an accurate process for the separation of rosin from the fats and its quantitative estimation has long been felt. To meet this need numerous methods have been proposed. Thus in Prescott's "Proximate Organic Analysis," p. 90, are recommended two: the first dependent on the treatment of the fat acids containing the rosin, with petroleum naphtha; the second, on the treatment of the same with a mixture of water and a nearly equal volume of alcohol. I have given these plans a careful trial, using for the purpose a mixture of known amounts of pure fat and pure rosin, but have found them wholly unreliable, as they fail to give even an approximate determination of the rosin known to be present.

A later and better method is found in "Spon's Encyclopedia," p. 1469, in which the rosin and fats are brought into the form of neutral soda salts. After a careful drying by evaporation mixed with sand, these are digested in a mixture of absolute alcohol and ether, by which the resinates of soda are dissolved. But this method is very laborious, requiring at a later stage the use of a polariscope, and even then giving a result several per cent from perfect accuracy, especially when the amount of rosin present is small.

The difficulty underlying the problem is the great similarity as regards solubility between oleic acid or its salts and the resins. Every solvent for the one in the above schemes is to a considerable degree a solvent for the other. A systematic search has therefore been made for such a salt and such a solvent as shall serve to distinctly separate these two substances.

A plan of separation analogous to the separation of oleic acid from stearic and palmitic acids by digesting their lead salts in ether, thereby dissolving out the oleate of lead, has been investigated, and found to be entirely satisfactory both as regards accuracy and ease of execution.

The fatty salts of silver were found to be almost perfectly insoluble in ether, while the resinates of silver was found to be readily and abundantly soluble therein. A small percentage of alcohol does not affect the solubility

* From the *American Chemical Journal*, vol. iii., No. 6.

of either, and for the sake of an advantage gained thereby was used in the course of experiments undertaken.

In applying this principle of separation, the silver salts of the three acids were at first precipitated from a perfectly neutral water solution of the potash salts by a neutral solution of silver nitrate. But the difficulty attending the filtering and washing of this precipitate, and the somewhat inaccurate results obtained, which were attributed partly to the decomposition of the silver salts from exposure during drying preparatory to treating with ether, caused its abandonment.

The following plan was finally adopted with success:—About 0.5 gm. of the fat acids containing the rosin is introduced into a small flask; 20 c.c. of 95 per cent alcohol are added, and the flask rotated till the fat acids and the rosin are dissolved. A drop of phenol phthalein is now added, and then a saturated solution of caustic potash in alcohol drop by drop, with thorough agitation after the addition of each drop, until the deep red colour characteristic of alkalinity is obtained. One or two additional drops are now added, and the flask placed on a water-oven and kept at the temperature of boiling alcohol for ten minutes, to ensure the saponification of the last portions of fat. The flask should be loosely corked. It is now cooled, and the contents washed into a graduated 100 c.c. cylinder by means of concentrated ether. The cylinder is filled with the ether exactly to the 100 c.c. mark; then corked (best by a common cork twisted tightly in), and the contents mixed by a moment's shaking. About 1 gm. of C.P. neutral silver nitrate is now rubbed to an impalpable powder in a small mortar, and then introduced into the cylinder. The latter is vigorously shaken for ten or fifteen minutes until the flocculent precipitate of silver stearate and oleate collects in the same manner as silver chloride upon shaking, and settles clear; 50 to 70 c.c. of the supernatant liquid are now syphoned off by means of a slender syphon, previously filled with ether, into a second 100 c.c. cylinder, passing the liquid through a small filter-paper if it is not perfectly clear. A small quantity of pulverised silver nitrate is shaken up with this, to make certain that all the oleate and stearate are precipitated. If no flocculent precipitate appears this is the case. 20 c.c. of a mixture of hydrochloric acid and water, one-third the former and two-thirds the latter, are now added, and the cylinder vigorously shaken until the decomposition of all the silver salt present is complete. After the silver chloride has settled, an aliquot portion of the supernatant ether solution is syphoned off into a platinum dish and evaporated on the top of a water-oven to dryness. The residue is rosin containing a small amount of oleic acid, which can be accurately allowed for.

The following experiments will show the allowance to be made for the oleate of silver retained in solution, as well as the reliance which can be placed upon the process for accuracy:—

Exp. 1.—One-half a gm. of pure fat acid was treated according to the above plan, but with one-half the amount of alcohol and ether.

Forty c.c., shaken with HCl and evaporated, gave 0.0095 gm. of residue. 10 c.c. contain 0.00237 gm. of oleic acid.

Exp. 2.—One-half a gm. of pure fat acid was treated in the same way with full quantities of liquid.

Eighty c.c., shaken with HCl and evaporated, gave 0.0188 gm. of residue: 10 c.c. contain therefore 0.00235 gm. of oleic acid. This very small and accurate correction of 0.00235 gm. for every 10 c.c. of liquid shaken up with HCl was applied in the subsequent experiments.

Exp. 3.—Some pure white Castile soap was decomposed by acid. One-half a gm. of the fat acids from the soap was added to 0.050 gm. of common yellow rosin (colophony), and the whole treated as above. After corrections 0.0497 gm. on the whole quantity taken was obtained instead of 0.050 gm.

In order to ascertain whether the process would succeed linseed oil, in which rosin is often to be determined,

and also to test the process when very small quantities of rosin are present, the following experiment was made.

Exp. 4.—One half a gm. of the fat acids from linseed oil was added to 0.050 gm. of rosin, and treated as the above.

Seventy c.c., shaken with HCl, gave 0.0517 gm. of residue. Subtracting the allowance for 70 c.c.—namely, 0.0164 gm.—leaves 0.0353 gm., or 0.0504 gm. of rosin on the whole quantity taken, instead of 0.050 gm. taken.

As the principal value of the above process will be found in the estimation of rosin in soaps, of which it forms so frequent an adulterant, a number of experiments were made according to the above plan on the soap itself, dispensing with the preliminary decomposition of the soap in order to obtain the fat acids,

One gm. of the soap in thin shavings is dissolved in the alcohol, and treated in every way as above. Particular care is paid to the saponification as above directed, in order to make certain that no trace of unsaponified fat is left. This would pass through the remaining stages unchanged and increase the percentage of rosin. The results are so good and the process is so much simplified that this plan is recommended for commercial analysis. The determination of the percentage of fat acids is thereby avoided, and the time required for the process is shortened to a few hours. Pure soap free from rosin was used.

	Soap taken.	Rosin added.	Rosin found after correction.
<i>Exp. 5.</i>	—0.250 gm.	0.0200 gm.	0.0197 gm.
<i>Exp. 6.</i>	—1.000 „	0.0200 „	0.0209 „

Some experiments made by filtering the whole of the liquid instead of taking an aliquot portion as above did not give as accurate results, both on account of the difficulty of perfectly washing the flocculent precipitate and the lesser degree of accuracy in making allowance for the oleate of silver dissolved.

Duplicate analyses of a cheap yellow soap known to contain rosin gave 29.00 per cent and 29.30 per cent of rosin present.

Some experiments to determine the applicability of the above process to the estimation of mineral oils and paraffin in the other fatty oils are contemplated; also a preliminary trial of a similar method of separating oleic acid from the other fat acids gives promise of accomplishing this with great accuracy.

Laboratory of Stillwell and Gladding, New York.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, April 6, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—L. W. Andrews, J. H. Bicket, B. B. Burrell, J. Falkiner, G. R. Faulkner, S. Langdon, A. F. Price, S. R. Saddler, W. C. Samuel, J. H. Smith, G. Watson.

THE PRESIDENT then called on Mr. W. H. PERKIN to read a paper "*On the Action of Acetyl Chloride on Fumaric Acid.*" The author, having referred to his previous experiments on the formation of maleic anhydride from fumaric acid by heating it to 100° with acetyl chloride and acetic acid, and also to his experiments on the formation of aceto-maleic anhydride, and its decomposition into acetic acid and maleic anhydride when distilled, discusses Auschütz's explanation of the first reaction, in which aceto-maleic anhydride is supposed to be formed, and then decomposed by distillation into maleic anhydride and acetic acid. This supposition is shown by the author of the present paper to be untenable, because the product

of the action of acetyl chloride and acetic acid on fumaric acid contains maleic acid before it is distilled. The recent paper of Anschütz and Bennert is then considered, as well as fresh experiments made by the author. He concludes that the views of the above chemists are unsatisfactory, and that the most rational way of viewing the reaction is to assume that the acetyl chloride removes a molecule of water from the fumaric acid, yielding maleic anhydride, and that part of this unites with the hydrochloric acid formed in the reaction, producing chloro-succinic anhydride.

Mr. U. K. DUTT then read a paper entitled "*Some Arguments in Favour of the Prism Formula of Benzene.*" This is a somewhat lengthy theoretical paper, in which the author adduces many arguments against the hexagon formula of Kekulé, and for the triangular prism formula of Ladenburg. He has also worked out from this point of view the graphic formulæ of naphthalene, phthalic acid, diphenyl, stilbene, anthracene, phenanthrene, &c.

Dr. JAPP entirely disagreed with the arguments of Mr. Dutt, and considered that he had numbered the prism in rather an arbitrary manner, and that taking as granted the ordinary definitions of ortho-, meta-, and para-compounds, he had represented phenanthrene as a meta-compound, while it was really an ortho-body. As to the comparative merits of Kekulé's and Ladenburg's formulæ, it seemed to the speaker that it was a choice of the least of several evils, and that both formulæ led to hopeless contradictions.

The SECRETARY then read, in the absence of the respective authors, the following papers:—

"*Note on a Convenient Apparatus for the Liquefaction of Ammonia,*" by J. EMERSON REYNOLDS. This apparatus consists of two stout vertical wrought-iron tubes about 30 to 40 c.m. long and 2 c.m. internal diameter. These are closed at their lower ends and connected by an iron tube, 25 c.m. long and 5 m.m. internal diameter; the three tubes forming a square U-tube. The upper ends of the vertical iron tubes are closed by two iron screw caps furnished with leather washers. One of these caps is solid, the other is perforated, with a conical hole, into which is firmly cemented a long stout glass tube, having its upper end open, and its lower end drawn out and turned up into a hook. To use the apparatus, the iron U is filled with mercury; the glass tube with iron cap attached, is filled with dry ammonia, and while full has its upper end sealed by the blowpipe; the lower end is closed by some mercury placed in the turned up end. The iron cap with the glass tube containing the ammonia is screwed into one of the upper ends of the iron U-tube, the turned-up end of the glass tube being in the mercury which fills the iron U-tube. Some mercury is now withdrawn from the other leg of the U, the leg filled up with the strongest ammonia solution, and the solid iron cap screwed on the top. The apparatus now practically consists of a continuous closed tube, at one end of which is strong ammonia solution, at the other a glass tube containing dry ammonia gas, the intervening space being filled with mercury. On heating the end of the tube containing the ammonia solution, pressure is generated, which is increased by gentle warming until the ammonia gas in the glass tube is liquefied. The author states that the apparatus is easily managed, whilst it is strong and inexpensive. It is made by Yeates and Son, Dublin.

"*On the Transformation of Urea into Cyanamide,*" by H. J. H. FENTON. It is well known that cyanamide when treated with dilute acids takes up the elements of water, forming urea. In fact, taking the ordinary view, urea is the amide,—



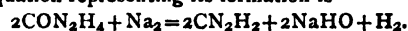
whilst cyanamide,—



is the nitrile of carbamic acid,—

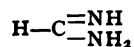


Ammonium carbamate loses water, forming urea, and sulphur-urea similarly parts with the elements of hydrogen sulphide, forming cyanamide. The direct dehydration of urea in cyanamide has not hitherto, however, been effected. The author made various unsuccessful attempts with phosphoric pentoxide, calcium chloride, &c. On gently heating urea with metallic sodium a violent reaction ensues, hydrogen is evolved, and a soluble residue is left, which gives the characteristic reactions of cyanamide, a yellow precipitate insoluble in cold ammonia but soluble in dilute nitric acid, and a brownish black precipitate with cupric salts. The yellow silver precipitate was decomposed, under ether, with hydrogen sulphide; the pure product had on analysis the composition of cyanamide. The equation representing its formation is—



Ammonium carbamate and carbonate also yield cyanamide when treated with metallic sodium. The author is investigating the composition of the yellow silver compound.

"*On the Action of Haloid Acids upon Hydrocyanic Acid,*" by L. CLAISEN and F. E. MATTHEWS. On adding pure dry acetic ether, free from alcohol, to about its own volume of dry hydrocyanic acid prepared according to Wöhler's directions, cooling the mixture in ice and salt, and passing hydrochloric acid gas, a rapid absorption of the gas takes place, and in three or four hours a nearly solid product is obtained. This crystalline mass was washed with acetic ether, dried, and analysed; it has the composition $2\text{HCN} + 3\text{HCl}$. Hydrobromic acid has a similar action. On treating the above compound with alcohol, hydrochloric acid, ethyl chloride, ammonium chloride, and the hydrochloride of a base—



are formed. The authors believe that the compound obtained by Gautier is identical with the body $2\text{HCN} + 3\text{HCl}$, obtained above, as the two bodies resemble each other physically and give identical reactions. Gautier assigned to his substance the formula $\text{HCl} + \text{HCN}$.

The Society then adjourned to April 20th, when the following papers will be read:—"On Specific Volumes," by Dr. Ramsay; "On the Behaviour of Zinc, Magnesium, and Iron as Reducing Agents on Acidulated Solutions of Ferric Salts," by T. E. Thorpe; "On the Action of the Oxylchloride of Sulphur on Silver Nitrate," by T. E. Thorpe; "On the Action of Thiophosphoryl Chloride upon Silver Nitrate," by T. E. Thorpe; "On the Action of Acetone on Phenanthraquinone, both alone and in the presence of Ammonia," by F. R. Japp and W. Streatfield.

NOTICES OF BOOKS.

On the Morbid Conditions of the Urine Dependent upon Derangements of Digestion. By C. H. RALFE, M.D. London: J. and A. Churchill.

THIS treatise scarcely belongs to the class of works commonly noticed in our columns. The author treats of a certain class of urinary derangements—those, namely, which spring from chemical changes in contradistinction to such as are connected with diseases of the kidneys and urinary passages, or spring from deranged circulation in the kidneys and liver. Incidentally he remarks that there is "no department of clinical medicine so perfunctorily performed as the examination of urine in disease." The total acidity and the quantity of solid matter voided daily are seldom determined. This circumstance is much to be regretted. In the succeeding pages Dr. Ralfe treats of the formation of acid in, and its removal from the body; of dyspepsia associated with an acid or with an alkaline condition of the urine; of derangements associated with deposits of uric acid and of oxalate of lime, or with excessive elimination of phosphoric acid; and, lastly, on the

effect of the bicarbonate of potash upon the acidity of the urine. Under this last head we learn that if alkaline carbonates are taken on an empty stomach the acidity of the urine is only slightly depressed, and rises the day following higher than before. If taken during the process of digestion, however, the acidity of the urine entirely disappears, and there is no marked increase of acidity the day following. The quantity of phosphoric acid eliminated in twenty-four hours averages from 2.5 grms. to 0.3 grm. In doubtful cases Dr. Ralfe recommends its quantitative determination, since its excessive elimination, if long continued, is attended with grave constitutional disturbance. This state approximates so closely to *Diabetes insipidus* that it has received the name of phosphatic diabetes.

Gout the author considers to be closely related to scurvy, and as due to chemical alterations in the quality of the blood, chiefly in the direction of decreasing alkalinity. Excessive excretion of uric acid and urates is noticed as frequent in strumous and tubercular subjects. As regards the treatment which the author proposes for the various diseases referred to we are not competent to form an opinion. The perusal of this little work, however, convinces us that medicine is making rational progress, and if not frustrated by fanatical agitators will ultimately take the rank of an exact science.

Tables for Qualitative Chemical Analysis, with an Introductory Chapter on the Course of Analysis. By Prof. H. WILK, of Giessen. Edited by C. F. HIMES, Ph.D. Philadelphia: H. C. Baird and Co.

THESE tables—as may be inferred from the fact that they have passed through eleven editions in Germany—have given very general satisfaction to professors and students, and scarcely admit of comment. The volume before us is the third edition of an American version based upon the eleventh German edition, and containing the author's latest additions and emendations. It may consequently be regarded as a trustworthy manual for the student and work of reference for the more advanced chemist.

Dr. G. Krause's Chemiker-Kalender auf das Jahr 1882. (Chemists' Calendar for the Year 1882.) Göttingen: Verlag der Chemiker Zeitung.

WE have here a most useful compilation, containing a surprising amount of information compressed into comparatively brief compass. The first part of the book (164 pages) is arranged to serve as a pocket diary. Upon this follow a few pages for the entry of addresses. Next comes a table of the elements with their symbols, atomic weights, and equivalents; a table of German weights and measures, on the metric system; comparative tables of the money, weights, and measures of the principal nations; German and Postal Union postal regulations; and the German laws concerning bills of exchange. Then follows a table of means for removing spots from textile goods, which, however, would not be quite safe in the hands of a person not acquainted with the special behaviour of animal and vegetable fibres in contact with the different reagents. Next we come to the analytical section, where are brief instructions for the detection of bases and acids; tables of strengths of reagents; table of logarithms; table for calculating the quantity of bodies required from the weights obtained in analysis; auxiliary tables for organic analysis; preparation of normal solutions, directions for preparing molybdic solution, magnesia mixture, Fehling's solution, Nessler's reagent, &c.; for the analysis of manganese, chloride of lime, milk, beer, wine, flour, soap, alkalies; table for finding the percentage of starch in potatoes from their specific gravity; rules for the volumetric determination of phosphoric acid; table of the average composition of artificial manures and their ingredients, with especial reference to the various kinds of Stassfurt salts; composition of certain kinds of agricul-

tural produce and industrial refuse; specific gravity, melting- and congealing-points of lubricants; table of the formulæ, atomic and molecular weights, specific gravity, melting- and boiling-points, and solubility of the most important bodies; among which we notice most of the commercial coal-tar products. Then follow tables of physical constants, comparisons of hydrometer and thermometer scales, and percentage composition of a great number of solutions in comparison with their specific gravity.

The fifth section contains laws and regulations which especially concern the chemist. We note that in Germany all professors and teachers of chemistry, works' chemists, professional analysts, chemists at experimental stations, and pharmacutists are bound under severe penalties to give if called upon evidence before the courts, to undertake chemico-legal investigations, and to furnish reports and opinions. An expert so called upon receives for his time a sum not exceeding 2s. for each hour or fraction of an hour, the day to be counted at not more than ten hours. According to this scale the time of the most able chemist is valued at about £300 yearly. Extra payment appears, however, to be allowed for reagents consumed and special apparatus required. Travelling costs are allowed indeed, but on what seems to us a very penurious scale. If the expert is obliged to remain away from his usual residence for any length of time he receives for his expenses 5s. per day and 3s. per night. We certainly prefer the English system, which allows professional men to set their own value upon their time and trouble.

The remainder of the work consists of abstracts of the German laws on patents, trade-marks, &c.; on dangerous trades, and compensations due to persons injured. A table of poisons and antidotes forms an appropriate close.

Many of our readers will be apt to imagine that a volume containing such a quantity of matter must be inconveniently bulky. This is by no means the case. The paper is thin but of a fine quality, the type is small but clear, and the utmost brevity has been observed in style. We are glad to notice that the author and publisher eschew the "spelling reform" which so many of their contemporaries indulge in. The "Chemiker Kalender" may be safely recommended to all chemists who are acquainted with the German language.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 13, March 27, 1882.

Double Decompositions of the Haloid Salts of Silver.—M. Berthelot.—The reactions of the haloid silver salts are effected in virtue of the same principles as those of the mercurial salts, as described in former memoirs. Direct double decompositions are observed, representing the fundamental phenomenon and inverse phenomena, which are effected in certain conditions upon small quantities of matter.

Speed of Propagation of Explosive Phenomena in Gases.—MM. Berthelot and Vieille.—The authors examine whether the minute detonators employed to interrupt the electric currents of the registers determine the law of the propagation of ignition, and they conclude that the speed observed is independent of these detonators. They conclude also that it is independent of the diameter of the tubes employed, and is little affected by pressure.

Telephonic Indicator of Torsion and of the Speed of Rotation of the Motor Axle of Machines, and consequently of Work.—C. Resio.—The author, re-

ferring to an arrangement which he laid before the Academy in 1880, announces that he has contrived a new apparatus which may be applied to any machine by a suitable modification of the transmitter, and by which a single observer placed at any distance from the machine, may measure the torsion and the angular speed of the motor axle, and, in consequence, the work of the machine. The principle upon which the invention is based is thus announced: If in a circuit containing a battery and a current-interruptor capable of giving a sound, there are two identical coils, A, A', arranged in tension, the one to the right and the other to the left, the induction-currents excited in two other coils (induced) B and B', equal in every respect and connected in tension in a circuit containing a telephone, destroy each other, and in consequence the telephone will be silent if they are equidistant from the inducing coils A, A', but it will emit a sound if the distances are unequal.

Compressibility of Gases.—E. Sarrau.

The Relation $\phi(p, t) = 0$ in Reference to Gases, and the Law of Expansion of these Bodies under a Constant Volume.—E. H. Amagot.—These two papers do not admit of useful abstraction.

A certain Class of Equipotential Figures, and the Hydraulic Imitations of M. Decharmes.—A. Guéhard.—This paper cannot be intelligibly reproduced without the accompanying diagrams.

Action of Telephonic Currents upon the Galvanometer.—M. de Chardonnet.—If in a telephonic circuit there is substituted for the receiver a very sensitive galvanometer, and if the transmitter is acted upon by means of an organ pipe, we observe no deviation as long as the sound preserves its intensity, but as it increases or diminishes the needle deviates.

Absorption-spectrum of Ozone.—J. Chappuis.—The absorption-spectrum of ozone characterises alone this gas better than any other of its chemical or physical properties. This optical examination is sensitive enough to detect traces of ozone if we operate with a gaseous column of sufficient length. The author has determined the position of eleven bands of this absorption-spectrum, expressed in wave-lengths. The luminous ray analysed had traversed a tube 4.50 metres in length, full of ozonised oxygen prepared at the pressure of the atmosphere and at a temperature of 15°. The band No. 1 was only observed twice when the ozone had been prepared with unusual care. The second band is the most distinct of all, but is not equally dark in its entire width. The third band is darkest in the region bordering upon D; its maximum falls near 5735, and it decreases towards E. In the region about and between G and H, the ozone absorbs partially the light without producing bands. As in the case of hyponitric acid the dark bands appear successively; 2 and 3 appear first, enclosing the ray D. They must always be sought for in experiments as characteristic of ozone. The bands 5, 6, and 8 appear in succession; 10 and 11 follow almost together. It is only in the most successful experiments that the bands 4, 7, and 9 are seen, and even then 1 is difficult to detect. A fall of temperature increases both the number and the intensity of the visible bands.

Researches on Ozone.—M. l'Abbé Mailfert.—The author has studied the action of ozone upon organic matter; upon various metallic oxides and sulphides, and upon salts whose bases are capable of becoming peroxidised. Mercurous salts are all attacked. The nitrate yields mercuric nitrate and a yellow precipitate of trimercuric nitrate. The sulphate gives analogous products. Mercurous chloride and bromide yield the corresponding mercuric compounds, mixed with oxychloride or oxybromide. The iodide is attacked very slightly, giving traces of oxyiodide. Silver nitrate, sulphate, chloride, and cyanide all yield black silver peroxide. Palladium nitrate and chloride are decomposed, yielding the binoxide. Cobalt and nickel sulphates, nitrates, and chlorides are

slowly attacked; the protoxides pass into the state of peroxides. All the basic and many of the neutral lead salts yield lead peroxide. The salts of manganese give rise to three kinds of products, a black or brown precipitate, a violet solution, and a brown, reddish, or yellowish solution. Chromium sulphate and chloride yield chromic acid, or in presence of ether perchromic acid. Ferric oxide in presence of potassa passes into potassium ferrate.

Action of Saline Solutions upon Stannous Oxide.—A. Ditte.—In their action upon stannous oxide the soluble bases are divided into two classes: those which dissolve it, such as potassa, soda, and baryta, and convert it into the crystalline anhydrous oxide; and those which, like ammonia, do not perceptibly dissolve the hydrate nor cause it to experience any kind of modification.

Experimental Researches on the Constitution of Cements and the Theory of their Setting.—H. le Chatelier.—The author recognises in Portland cement the following compounds:—Tricalcic aluminate, calcareous peroxide, calcic aluminoferrite, and certain magnesian bodies not determined. Cements which set rapidly are always very aluminous.

Campholurethane.—A. Haller.—This compound, $C_{17}H_{19}NO_2$, forms brilliant crystalline needles, soluble in boiling alcohol, in chloroform, benzol, carbon disulphide, and glacial acetic acid. It melts at 185° to 187°, and is partially decomposed if boiled with water.

Preparation of Pure Carbons for the Electric Light.—M. Jacquelin.—The author proposes to purify retort coke by steeping it in hydrofluoric acid diluted with twice its weight of water.

Die Chemische Industrie. Vol. 5, No. 2.

Statistics of Personal Accidents in the Chemical Industries of Germany.—Returns have been given in by 135 members of the Society for the Promotion of Chemical Industry, employing a total of 17,345 persons. The results are in some respects unexpected. The chemical manufactures are divided into eight groups. No. 1. Scientific chemicals, alcoholic preparations, organic acids and their salts, alkaloids, photographic and pharmaceutical chemicals; 33 works, 2520 work-people; percentage of accidents, 1.87. No. 2. Distillation of tar, coal-tar industry, and organic dyes; 19 works, 2367 work-people; accidents, 5.28 per cent. No. 3. Stassfurt industry; 5 works, 1078 work-people; accidents, 6.68 per cent. No. 4. Glue, gelatine, oils, lacquers, and varnishes; 6 works, 272 work-people; accidents, 0.00 per cent. No. 5. Alkali works, including potash; 40 works, 8610 work-people; accidents, 2.88 per cent. No. 6. Ultramarine, mineral colours, metals, and metallic salts; 14 works, 883 workmen; accidents, 1.36 per cent. No. 7. Explosives, matches, &c.; 6 works, 949 workmen; accidents, 0.95 per cent. No. 8. Chemical manures; 12 works and 666 workmen; accidents, 2.10 per cent. These returns extend only over the space of four months, but even in this short time the low proportion of accidents in the explosive class appears remarkable. The deaths were confined to Groups 1, 2, and 5, and were 11 in number, or 2.09 per cent of the total persons employed in chemical manufactures.

Process for Purifying and Utilising Town Refuse and Sewage.—E. Kunath and A. Aind.—The solids are separated by manual labour and burnt in a roasting-furnace. The combustion gases, after passing through chambers where dust, &c., is deposited, enter a tower where they meet with an absorptive liquid flowing downwards. This liquid enters a tank where it is mixed with the ashes from roasting the solids and the water of the sewers. The mixture is conveyed into a filter-press, where it is separated into solids and liquids. The latter are so purified with lime, &c. (?), that it can be let flow without injury into public water courses (!).

Les Mondes, Revue Hebdomadaire des Sciences.
No. 6, 1882.

Action of Time upon Ferric Hydrate.—D. Tommasi and G. Pellizari.—The authors conclude that the slight solubility in acids of ferric hydrate which has been kept for some time under water, does not depend on a complete modification of the whole of the hydrate, but merely on the transformation of a portion into the insoluble state. At the same time there is produced a small quantity of a ferric hydrate soluble in water. Light, direct or diffused, has very little influence on this transformation.

Note on the Presence and the Determination of Copper in Bread.—Jules Van Dens Berghe.—The author concludes that wheat normally contains copper to the extent of 8 to 10 parts per million. He has experimented with grain, the seed of which had not been "pickled" with sulphate of copper (as is often done to prevent smut), and has satisfied himself that the copper was not due to any impurity in his reagents, or to the gas-pipes and burners.

No. 7, 1882.

Synthesis of Methyl-pyridine.—G. Zanoni.—The author sought to prepare pyridine and its derivatives by mixing with glycerin the amides of the fatty acids and withdrawing the elements of water from the mixture. In place of the six substances expected he obtained only one, the β -pyridine of Weidel.

"Disinfection" of Alcohols of Bad Taste by Electrolysis.—Laurent Naudin.—This paper requires the four accompanying illustrations.

No. 8, 1882.

The Chlorides and the Hydrochlorates.—Dr. Charles Brame.—On comparing the coloured anhydrous chlorides to the corresponding hydrated chlorides they are found to differ decidedly in colour. On comparing the coloured hydrated chlorides with the coloured hydrated sulphates, their colours are found to be identical, or at least analogous. The anhydrous chlorides are not salts. They become salts, as does anhydrous ammonia, united to an anhydride by the addition of the elements of water. The chlorides, hydrated or dissolved, are hydrochlorates. The other haloid compounds, bromides, iodides, cyanides, sulphides, only become salts when hydrated or dissolved in water.

Moniteur Scientifique, Quesneville.
February, 1882.

Action of the Different Sugars upon Fehling's Liquid.—Dr. Soxhlet.—From the *Journal für Praktische Chemie*.

Discussion on the Inconveniences and the Dangers of Impure Chloroform.—A prolonged medical discussion at a meeting of the Société de Chirurgie.

Industrial Society of Mulhouse.—Meeting of December 14th.—M. Witt gave an account of the method of Mr. C. F. Cross for bleaching jute by means of dilute solutions of alkaline bisulphite applied under pressure.

M. Jules Meyer read a report on two samples of pipe-clay sent by MM. Beneke and Wimpessinger, of Loeban, as candidates for the bronze medal offered for a pipe-clay in impalpable powder perfectly free from grit, so as to be fit for use in thickening colours for machine work.

Meeting of January 11th, 1882.—A report was adopted that the method of bleaching jute proposed by Mr. Cross does not attack the fibre, which is much injured by chloride of lime.

Note on the Black Spots formed during Dyeing Scarlets on Wools.—Jules Degermann. (Read before the Mulhouse Society.)—The author refers these spots to stannous hydroxide, which is fixed upon the wool if stannous chloride is used as a mordant, and which on boiling is converted into a black anhydrous oxide. The

spots are avoided by using as a mordant the preparation known as "nitrate of tin," and also by the addition of oxalic acid.

Note on a Compound of Quinine and Quinidine.—C. H. Wood and E. L. Barret.—From the *CHEMICAL NEWS*.

Risks of Fire which may be occasioned by Electric Lighting, and on the Means for their Prevention.—From the *Sanitary Engineer*.

Researches on the Composition of the Bones in Animals which have received a Diet Poor in Phosphoric Acid and in Lime.—MM. Weiske and E. Wildt.—No change was detected either in the chemical composition or the physical condition of the bones, though the health of the animals suffered much.

Electro-metallic Procedures employed in the "Christoffe" Establishment.—H. Bouilhet.—From the *Bull. de la Soc. d'Encouragement*.

The Alkaloids of Nux Vomica.—W. A. Shenstone.—From the *Pharmaceutical Journal*.

Note on the Utilisation of the Residues of Distilleries.—A. Ckandi Bey.—From the *Bull. de la Soc. d'Encouragement*.

Review of Chemical Researches Published in Germany.—A series of extracts from the *Ber. der Deut. Chem. Ges., Liebig's Annalen, &c.*

Rove, a New Tanning Material.—From the *Journal of Applied Science*.

Gum Pistachio.—Jules Greth.—From the *Journal of the Society of Arts*.

Turkey-Red Dyeing.—From the *Scientific American*.

Process for the Detection of the Alkaloids.—Setting out from the fact that the colourations produced by the reactions of the alkaloids depend on the dehydration occasioned by the reagents, Czumpelitz proposes to use zinc chloride to distinguish them from each other. The substance to be examined is first carefully dried, moistened with solution of zinc chloride, and dried again. The solution is made up with 1 gm. melted zinc chloride and 30 c.c. of water. If thus treated strychnine takes a scarlet colour, thebaine a yellow, narceine an olive-green, delphinine a red-brown, berberine a yellow, veratrine a red, quinine a pale yellow, digitaline a maroon, salicine a violet-red, santonine a violet-blue, and cubebine a purple. The presence of brucine prevents the colouration of strychnine, the tinge produced being a dirty yellow.—*Giornale Farm. Chim.*

Journal de Pharmacie et de Chimie.
January, 1882.

Continued Ingestion of Lead in Diet.—A. Gautier.—The author calls attention to the numerous sources through which lead is now being introduced into the human system.

Mineral Antiseptic Liquor of Huet.—This is a mixture of the chlorides of aluminium, potassium, iron, and calcium, together with a small quantity of gelatinous silica. It is obtained by treating lava with hydrochloric acid, and is recommended as efficacious and very cheap, though the price quoted, 5 francs per litre, seems to us high.

February, 1882.

Chemical Studies on the Skeleton of Plants.—MM. E. Fremy and Urbain.—Already noticed.

The Electric Exhibition.—M. le Roux.—A repetition of matter already known.

Crystalline Hyoscyamine.—M. Duquesnel.—The author considers that notwithstanding the close resemblance existing among the alkaloids of the Solanaceæ and of the Duboisia, the identity of their physiological action is not sufficiently demonstrated.

MEETINGS FOR THE WEEK.

MONDAY, 17th.—Medical, 8.30.
TUESDAY, 18th.—Institute of Civil Engineers, 8.
— Pathological, 8.30.
— Royal Institution, 3. "History of Customs and Beliefs," by Dr. E. D. Tylor.
WEDNESDAY, 19th.—Meteorological, 7.
— Society of Arts, 8. Discussion on "The Channel Tunnel," to be opened by Sir Edward Watkin, Bart., M.P.
THURSDAY, 20th.—Chemical, 8. "On Specific Volumes," by Dr. Ramsay; "On the Behaviour of Zinc, Magnesium, and Iron as Reducing Agents on Acidulated Solutions of Ferric Salts," by T. E. Thorpe; "On the Action of the Oxichloride of Sulphur on Silver Nitrate," by T. E. Thorpe; "On the Action of Thiophosphoryl Chloride upon Silver Nitrate," by T. E. Thorpe; "On the Action of Acetone on Phenanthraquinone, both alone and in the Presence of Ammonia," by F. R. Japp and W. Streatfield.
— Royal, 4.30.
— Royal Institution, 3. "The Metals," by Prof. Dewar.
— Royal Society Club, 6.30.
FRIDAY, 21st.—Royal Institution, 8. "Researches of H. Ste.-Claire Deville," by Professor Dewar, 9.
— Society of Arts, 8. "The Mineral Resources of India and their Development," by Prof. V. Ball, M.A., F.G.S.
SATURDAY, 22nd.—Physical, 3. "Some Electrical Phenomena in connection with the Telephone," Prof. A. E. Dolbear.
— Royal Institution, 3. "History of the Science of Politics," by Mr. F. Pollock.

ERRATUM.—P. 148, col. 1, line 15 from bottom, for "suspended below the liquid," read "suspended below the filter."

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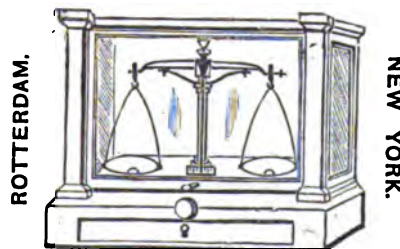
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	Titanic Acid	0'23	5'80	6'20	
	Lime, Magnesia, Potash, Soda, and Sulphuric Acid	22'30	0'83	1'14	
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FILTRATION UNDER PRESSURE

By BEAUMONT JEANNERET-GROSJEAN,
J. B. Lawes's Chemical Works, Millwall.

FROM P. Casamajor's note (CHEMICAL NEWS, vol. xlv., p. 148) I gather that he is not acquainted with the great extension which I gave to the use of his filtering disks (CHEMICAL NEWS, vol. xxxix., p. 182, and *Chem. Soc. Jour.*, 1879, *Trans.*, p. 341). I showed that the use of a funnel differing in shape from the ordinary funnel was unnecessary. The usual funnels can be used with perfect safety if care be taken to have the disk quite level. I have used these disks for several years, and find them a great boon. In the paper referred to I have shown that the disks have many advantages over the platinum cones. I drew particular attention to one point which will bear repetition. It is important, in filtration with the Sprengel water-pump, that the pressure on the surface of the substance be not very great, with few exceptions. A pressure indicated by 250 m.m. of mercury is quite enough for ordinary purposes. If a very great pressure is employed the substance is apt to drain and dry so quickly that it cracks before it can be washed. The water subsequently added would, of course, pass down these cracks and leave the main substance untouched. To obviate this it is usual to press the substance down firmly with a rod or spatula when the liquid has drained away. But this leads to two evils:—(1) It often forms an impenetrable mass, through which the liquid takes an extremely long time to pass; (2) if the pressure has not been exactly uniform over the whole surface, the liquid subsequently added will pass down that portion which has been least pressed, leaving the rest comparatively, or entirely, unwashed. This caution should also be borne in mind in filtration on the large scale under pressure: liquids will go down the easiest channel. There are some substances, indeed, which require a high exhaustion in order to force liquid through them; but in this case the atmospheric pressure is perfectly uniform, and, from the slowness with which the liquid drains, there is no fear of cracking.

VOLUMETRIC ESTIMATION OF COPPER AND OF LEAD.

By P. CASAMAJOR.

In this process copper and lead are precipitated from alkaline solutions by a titrated solution of sodic sulphide. This was the reagent used by Pelouze for the volumetric estimation of copper, in a process published some thirty years ago in the *Annales de Chimie et de Physique*. In the process of Pelouze copper is dissolved in a large excess of ammonia, by which an intensely blue liquid is obtained, and a titrated solution of sodic sulphide is added, until the blue colour disappears.

To titrate the sodic sulphide, 1 grm. of pure copper is dissolved in nitric acid, and 40 or 50 c.c. of concentrated ammonia are added. The liquid is placed in a flask, and heated to boiling, and sodic sulphide is dropped in the flask until the blue colour disappears. The disappearance of the blue colour is ascertained by letting the precipitate settle and adding ammonia if necessary. The solution of sodic sulphide was found to keep very well in well stoppered bottles.

I have often used this process, and have always found that the end of the reaction is very difficult to seize. The brown colour of the sulphide interferes with the observation of the blue colour of the solution. Even when there is no other metal than copper present, an addition of the alkaline sulphide gives a precipitate after the blue colour has entirely disappeared.

Instead of using an excess of ammonia, I have used an alkaline tartrate dissolved in an excess of caustic soda. This liquid is the same which, added to a titrated solution of cupric sulphate, forms Fehling's solution. It is prepared by dissolving 173 grms. of Rochelle salt in 480 c.c. of caustic soda of specific gravity 1.14, and adding water to form 1 litre of solution. This alkaline solution is added to the copper solutions in slight excess of the quantity sufficient to dissolve the copper to a deep blue-coloured liquid, and the porcelain dish is heated so that the liquid is carried to nearly the boiling-point. The titrated solution of sodic sulphide is then added until no turbidity is produced by the addition of one drop.

In this manner of proceeding the blue colour of the solution is not taken into account. The dark brown colour which follows the addition of the reagent is the only guide. The first addition of the alkaline sulphide gives rise to an intense black-brown precipitate. As soon as this is formed the liquid in the dish is thoroughly stirred with a glass rod. This has the effect of agglomerating the cupric sulphide into coarse curds, which settle to the bottom of the dish, leaving the liquid clear and almost colourless. If after settling the liquid should not be sufficiently clear, it should be vigorously stirred again until the desired effect is obtained. After every addition of sodic sulphide the liquid should be thoroughly agitated until it becomes clear. The degree of turbidity produced is a guide as to the quantity of reagent to use.

At the beginning the brown cloud is very intense, and it is useless to await the complete clearing up of the liquid before adding more of the reagent. Towards the end the brown cloud is comparatively slight, and the reagent should be added drop by drop. The liquid in the dish should be stirred so as to clear it up entirely before adding a drop of the reagent.

By thorough stirring the sulphide of copper agglomerates in thick heavy curds, which settle rapidly, leaving the surface of the dish very clean, as seen through the clear liquid. On this clean white surface the faintest cloudiness is easily seen. A liquid containing 1 grm. of copper in 30,000 c.c. of solution will give a distinct brown turbidity by the addition of one drop of the reagent.

For the volumetric estimation of lead the same process may be applied. Sulphate of lead is easily dissolved in the alkaline tartrate solution described. Sulphide of lead is precipitated in exactly the same manner as sulphide of copper. The end of the reaction is equally definite.

As plumbic sulphate is insoluble in alcohol of about 60 per cent, lead can be separated as sulphate from other metals, and afterwards dissolved in the alkaline tartrate. Sulphuric acid could also be precipitated as plumbic sulphate, and estimated by this process. Other acids which form insoluble salts with lead could also be estimated in the same way.

Copper can be separated from other metals as sulphocyanate (Rivot's process). The precipitate is heated with nitric acid and re-dissolved. This solution is afterwards treated by the alkaline tartrate solution, and copper precipitated as sulphide. Copper may also be precipitated as cuprous oxide by glucose from an alkaline tartrate solution. The cuprous oxide may be dissolved in nitric acid, then alkaline tartrate solution added to obtain a clear blue solution, from which copper may be separated as cupric sulphide. This is applicable to testing glucose and cane-sugar.

These volumetric processes for copper and lead are founded on the easy agglomeration of the sulphides of these metals in the alkaline tartrate solution by agitation. The heavy clots fall to the bottom, leaving the liquid clear

In this clear liquid the dark cloud caused by the titrated solution of sodic sulphide is easily distinguished on the clean white surface of the porcelain dish. The operation takes only a few minutes. Other metals, whose sulphides agglomerate in heavy clots in the same way, can probably also be estimated by this process.

As chloride of silver agglomerates in curds by agitation in exactly the same way, the white cloud due to a fresh formation of this salt may very easily be observed over a black surface. A solution of sodic chloride, dropped into one of nitrate of silver, gives a very distinct white cloud, which is most distinctly seen if the precipitation takes place in a flat dish of black glass, or one of clear white glass, the under side of which has been covered with lamp-black. The best temperature for clearing up the solution by agitation is about 65° C. Chloride of silver, however, does not agglomerate so completely in an acid solution as the sulphides of lead and copper in the alkaline tartrate solution. In the slightly turbid liquid, as seen against the black background of the glass dish, we may, however, very easily distinguish the white cloud produced by the addition of a single drop of sodic chloride.

HOLLAND'S PROCESS FOR MELTING IRIDIUM.*

By W. L. DUDLEY.

THIS metal has been known to chemists for some years, although the public has had but little experience with it; even mining prospectors are, for the most part, unfamiliar with its appearance and properties.

In the year 1803 Smithson Tennant, while investigating the metallic residue which remained when platinum ores were dissolved in aqua regia, thought he had discovered a new metal. Descotils, Fourcroy, and Vauquelin were at the same time examining similar residues, and they also came to the conclusion that a peculiar metal was present; but, however, in 1804, Tennant announced to the scientific world that he had proved the presence of two new metals in these platinum residues, to one of which he gave the name of *iridium*, on account of the iridescence of some of its compounds; and to the other the name of *osmium*, because of the peculiar odour which its volatile oxide possessed.

Iridium is found in considerable quantities in the platinum ores; in the forms of platiridium, which is an alloy of platinum and iridium; and osmiridium or iridosmine, which is an alloy of osmium and iridium. The platiridium occurs in grains, and sometimes in small cubes with rounded edges. The iridosmine is usually found in the form of flat, irregular grains, and occasionally in hexagonal prisms.

The geographical distribution of this metal is quite wide; it is found in California, Oregon, Russia, East India, Borneo, South America, Canada, and Australia, and in small quantities in France, Germany, and Spain.

As we find iridosmine, or the so-called native iridium, it is associated with numerous rare metals, viz., osmium, platinum, rhodium, ruthenium, and palladium, and also with iron and copper.

Iridium possesses a white lustre resembling that of steel. In the cold it is quite brittle, but at a white-heat it is somewhat malleable. It is one of the heaviest of metals, having a specific gravity of 22.38. When an alcoholic solution of the sulphate of iridium is exposed to sunlight, it deposits an impalpable black powder, which has the very peculiar property of setting fire to a piece of paper saturated with alcohol when brought into contact with the slightest trace of it. When heated in the air to a red-heat the metal is oxidised, but on raising the temperature to

about 1000° C., it parts with its oxygen; hence, at a high heat (above 1000° C.) it is not oxidised. It is insoluble in acids, but is very slightly soluble in aqua regia when heated for many hours.

Iridium is one of the most difficultly fusible of all metals, as will be seen from the following partially successful attempts to fuse it: in Gmelin's "Handbook of Chemistry" (vol. vi.) we find the results of some of these experiments. "Vauquelin fused it in very small quantity only, on charcoal ignited in a stream of oxygen, and obtained a somewhat ductile globule." This could not have been pure iridium if the globule was ductile, as he states. "Children fused it by his galvanic battery into a white, strongly lustrous, brittle, and still somewhat porous globule, of specific gravity 18.68. This globule probably contained platinum (Berzelius). One grm. of iridium, heated upon charcoal before Döbler's oxy-hydrogen blowpipe, fuses into a bright globule, which, however, appears to absorb gas, since, on solidifying, it throws out excrescences, and cavities are formed in its interior."

Platinum, which melts at a much lower temperature than iridium, was first fused by Dr. Hare, of Philadelphia, the inventor of the oxy-hydrogen blowpipe. He succeeded in melting about 2 lbs. (971 grms.) at one time. He was also the first to melt iridium by this means.

As was before stated, the iridium which these old chemists claimed to have melted must have been impure, containing metals of lower melting-points, since one says he "obtained a somewhat ductile globule," and another found the specific gravity to be 18.68, when it is well known that pure iridium, in the cold, is not in the least ductile or malleable, and its specific gravity is 22.38. Alloys of platinum, with a small percentage of iridium, can be comparatively easily melted by the oxy-hydrogen blowpipe.

In a late determination, Violle estimates the melting-point of pure iridium at 1950° C., and platinum at 1750° C.

A few years ago MM. Deville and Debray succeeded in modifying Dr. Hare's blowpipe to such an extent as to obtain more satisfactory results, and in 1870 they prepared bars for the International Metrical System Convention, of 10 per cent iridium and 90 per cent platinum, and they successfully melted, in one charge, over 400 lbs. of this alloy. This work was carried out under the superintendence of Mr. Geo. Matthey, of the firm of Johnson, Matthey, and Co., of London. This alloy is largely in use for making platinum dishes, stills, and crucibles, as the iridium renders the platinum much stiffer and harder, and consequently more durable than the pure metal.

This brief outline of the history of methods which have been employed for fusing iridium brings us to within a few months of the present time.

At this stage of the subject I have the pleasure of presenting to you the results of the labours of Mr. John Holland, the well-known gold pen manufacturer of our city. Mr. Holland being engaged in the manufacture of what are known as diamond-pointed pens (the points being in fact iridium), it was quite natural that he should be impressed with the desirability of discovering some means of better preparing the metal to meet his own wants in his branch of manufacture. About eighteen years ago he commenced his experiments to that end, and never ceased his efforts, sparing neither time nor money in his determined pursuit of the object. At last his labours have been crowned with complete success. He placed a small quantity of the metal in a Hessian crucible, and after raising it to a high heat he quickly added a stick of phosphorus, when, greatly to his delight, as soon as the fumes cleared away, he saw the liquid mass of metal in the bottom.

It was at this stage of the discovery that the author of this paper became acquainted with it. For certain purposes for which it was proposed to use the metal, it was found necessary to remove the phosphorus which it contained, and this was the first problem that demanded attention. After various experiments, it was found that

* From the "Scientific Proceedings of the Ohio Mechanics' Institute," January 1, 1882.

lime was best adapted to the purpose. The metal, after being melted and cast into suitable shape, is embedded in lime contained in a Hessian crucible, and subjected to a very high heat. This process is repeated several times, each time allowing the metal to remain in the furnace longer than before; when, after four or five such operations, the phosphorus is practically all removed, having combined with the lime. For the want of a better name, and since the metal is rendered much tougher, we have termed this the annealing or dephosphorising process. The removal of the phosphorus renders the metal slightly porous, but it is as refractory as the original.

Having our time entirely occupied in experimenting with an aim toward practical results, we were unable to do much scientific work; but we are indebted to Prof. F. W. Clarke, of the University of Cincinnati, for assistance in this line. Prof. Clarke has undertaken an analysis of the fused metal, and, although his work is unfinished, he states that it contains about $7\frac{1}{2}$ per cent of phosphorus.* These analyses are accompanied by peculiar difficulties, since phosphorus is a new element for consideration in the analysis of platinum metals. This offers an interesting subject for research, which at some future time will be pursued.

On casting, we sometimes find the metal slightly porous. The polished surface, to the naked eye, may look perfectly homogeneous, but under the magnifying-glass minute holes may be seen.

In order to obtain the iridium in a convenient form for making pen points, the molten metal is poured upon an iron plate, when the workman immediately strikes it with a heavy iron, thereby flattening it out into a slab of about 1-32nd of an inch in thickness. This slab is broken into small pieces, which are then ground into the proper shape. The grinding is accomplished as follows:—A copper wheel, technically called a "lap," about 12 inches in diameter and $\frac{1}{4}$ inch in thickness, revolving at about 3000 revolutions per minute, is covered with fine emery or corundum mixed with oil. The emery embeds itself into the copper, forming a rough and sharp surface. When the object to be ground is too small to hold in the hand, it is soldered on a piece of brass, which, after the grinding, is dissolved in nitric acid, leaving the iridium free. One ounce of iridium yields from five to ten thousand pen points.

The iridium melted by this process is compact and crystalline; it is harder than the natural metal. Its tensile strength has not been determined as yet. The natural grains of iridosmine are sometimes laminated in structure and are liable to split in the direction of the lamination.

The operation of sawing the metal is accomplished by means of a copper disk, making about 5000 revolutions per minute, assisted by emery and water. When the metal is ground to a smooth surface by means of emery on a copper wheel, as described, it acquires a good polish, which may be increased by using "crocus powder" afterwards on a similar wheel.

Iridium which has been melted by Mr. Holland's process is nearly as hard as the ruby, which is next in hardness to the diamond. It cuts glass readily; the best files are ruined by attempting to file it. It has about the colour of steel. It is not attacked by acids, and does not tarnish. The best steel tools fail to make any impression upon it.

A metal with this wonderful combination of valuable properties, will undoubtedly find many uses to which it can be applied with great advantage; and, although we do not propose to mention all its applications, yet it may be of interest to state the result of our experiments with it, as applied to the electric light. Our first experiments were with the incandescent lamp, substituting iridium for

carbon, and using it in the open air. As far as the durability of the metal was concerned, the result seemed favourable; but it required such a large amount of electricity to accomplish the result, as probably to render this method of lighting somewhat expensive.

A short time ago, Mr. W. M. Thomas, of this city, called on Mr. Holland, requesting a piece of iridium to be used in connection with the arc light. Mr. Holland had a small piece prepared, which was substituted for the negative carbon of the lamp. The first experiment was tried for one-half hour, without any apparent effect on the metal. Since then more complete arrangements have been made, and the lamp containing the same piece of iridium has been in operation for over seventy hours without any appreciable loss of metal. The amount of electricity required to maintain it seems to be much less than for the ordinary lamp. The point of light is always in the same position, and, consequently, can be used in a reflector without the additional clock-work, which is employed to accomplish this result with the ordinary arc light. The light can be made very steady, since the lower carbon, which burns and crumbles away, is dispensed with. When the metal is used where it is subject to intense heat, the phosphorus is removed; but where hardness and non-corrosibility are required, the phosphorus does not offer any inconvenience.

NOTE ON THE PRECEDING PAPER.

By R. B. WARDER.

PROF. DUDLEY has shown that the phosphide of iridium is harder and more fusible than the native metal. It is probably more brittle. These facts remind us of the properties imparted to iron by the presence of phosphorus, carbon, and other non-metals. The physical properties of alloys, and the effect of small additions of non-metals, are subjects of the greatest importance, whether considered in their industrial or their scientific aspect. We need not look further than the discussion on steel rails by Dr. C. B. Dudley, and others (*Your. Frank. Inst.*, 1881), to see that such investigations are still in their infancy, even in regard to iron.

The "dephosphorising process" for the fused iridium bears a striking analogy to the use of a "basic" lining in the Bessemer converter, for the removal of phosphorus; in the latter case, however, the steel is melted, and the ingots are consequently homogeneous, while the solid bars of iridium become porous when the phosphorus is removed by heating with lime.

Prof. Dudley states that fused iridium has lately been used for the points of ruling and drawing pens, stiles, contact points for telegraph keys, and to replace agate in the bearings of analytical balances; it may soon be used also in the place of watch jewels and for bearings of the magnetic compass.

Principle of a New Photographic Revolver.—J. Janassen.—It is known that the principle of the photographic revolver consists in the rotatory movement of a sensitive plate upon which are produced successively, by means of a mechanical arrangement, images of the different phases of a variable phenomenon. But in this instrument the sensitive plate is stopped whenever an image has to be taken, and it only moves again to permit a neighbouring region, not yet acted upon, to receive a new image. Under these conditions a certain number of photographs may be taken per second, as has been done by M. Marey in his study on the flight of birds, but it is not easy to exceed the number of ten images per second. The author has succeeded in taking photographs upon a plate in motion at the speed of 0.15 metre per second, and finds that there is no limit to the possible number of images to be obtained in a given time.—*Comptes Rendus*.

* Two phosphorus determinations, by Prof. Clarke, gave 7.52 per cent and 7.74 per cent. Mr. O. T. Joslin found 7.38 per cent of phosphorus in the same sample. Osmium was found in traces only in the fused iridium.

LONDON WATER SUPPLY.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington; and late
Deputy Medical Officer of Health for the City of London.

February 15th, 1882.

SIR,—During the past year we have laid before you a report monthly, on the general condition and chemical composition of daily samples of the water delivered to London by the seven Companies taking their supply from the Rivers Thames and Lee. In the present Report we have reviewed and tabulated the results of our investigations and analyses of the 2181 samples that we have examined. Of these samples, 312 were taken from the mains of the New River Company, 307 from the mains of the East London Company, 315 from the mains of the Chelsea Company, 309 from the mains of the West Middlesex Company, 313 from the mains of the Lambeth Company, 317 from the mains of the Grand Junction Company, and 308 from the mains of the Southwark and Vauxhall Company.

We desire to remind you of the position we occupy with respect to this inquiry. All Reports, issued up to the time we commenced our work, related to a single sample of each Company's water, taken on one day only in the course of the month. Any criticism in praise or blame of the water supplied by that Company during an entire month was founded on the results yielded by that single sample. The Directors of the Water Companies felt, and we agreed with them, that it was quite impossible to judge fairly the purity or otherwise of a month's supply by an odd sample taken at random in the manner adopted. This might prove to be unsatisfactory, whilst the water supplied during the rest of the month was good, or *vice versa*.

Under these circumstances we advised the Companies, that the right way to meet the difficulty was, in our judgment, by the examination of a daily sample. And we accepted the responsibility of the task on the understanding that every detail relating to the times when, and the places where, the samples were collected, the methods of analysis to be adopted, and the form of the publication of the results obtained, should be left unreservedly in our hands.

This was on all points readily agreed to. We believe that nothing has been left undone to secure results, trustworthy in themselves, and sufficiently numerous to warrant the conclusions we venture to lay before you.

One general result of importance deducible from these examinations has reference to the amount of organic matter contained in the water. Taking the organic carbon as a trustworthy index of this organic matter, it appears that, contrary to popular though not to scientific opinion, the amount of organic matter present in the water supplied to London is, as a rule, exceedingly small. It is true that the variations in proportion appear at first sight to be considerable; but where the absolute amount of the organic matter in the water is so minute, never exceeding the $\frac{1}{100000}$ th of a per cent, the variations from about one-fifth of this amount and upwards, become for the most part quite insignificant.

Further, by an examination of the tables certain broad facts are brought out very prominently.

A close parallelism is for the most part seen to exist between the amount of organic carbon as determined by the combustion process and the amount of oxygen required to oxidise the organic matter as determined by permanganate. Despite some irregularities, the two quan-

ties sink together as the summer comes on, and rise again towards winter. Moreover minor fluctuations in the two quantities are in very many cases closely alike, and this so generally as to suggest that, for practical purposes of water analysis, permanganate affords indirectly a trustworthy measure of the organic carbon present in a water.

The connection between the greater or less colour-tint of the waters and the organic carbon is not quite so obvious. Still the broad fluctuations corresponding to the fall in summer and rise in winter are well marked; and some of the more decided oscillations are likewise reproduced. The blue, were it unmasked by the brown, would probably be constant in all cases, being the natural colour of pure water.

As these results are difficult to see from a mere examination of tables, we have reproduced them in the form of curves.

We now proceed to consider the several details in order, commencing with the colour of the waters.

Colour.

In describing the colour of a water, we adopted in the first instance, in common with chemists generally, certain arbitrary degrees of tint-depth, such as bluish green 0, green 1, &c., yellowish green 1, &c., brown 1, &c. From February 21st we made use of our new colour-meter, with which we had been experimenting for some time previously. This apparatus gives exceedingly accurate results, and is, in our opinion, a great improvement on all previous means (so far as we know them) for obtaining a standard of colour. Its mode of use is briefly as follows:—

Two hollow wedges are filled, one with a brown and the other with a blue solution,* and these are made to slide across each other in front of a circular aperture in a sheet of metal. In this way any desired combination of brown and blue can be produced. Each prism is graduated along its length from 1 to 50, the figures representing millimetres in thickness of the solution at that particular part of the prism.

On a level just below the prisms is a two-foot tube containing the water under examination, and having in front of it a circular aperture of the same size as the one in front of the prisms.

The stand supporting the prisms and tube is placed horizontally in front of an equably lighted window. The observer, standing a little distance off, sees two luminous disks, the lower one illuminated by light which has passed through two feet of the water, and the upper one illuminated by light which has passed through the respective thicknesses of the brown and blue solutions.

By sliding the prisms sideways one way or the other, it is easy to imitate with great accuracy the depth and tint of the colour of the lower or water-disk. A metal pointer affixed over the centre of the upper disk shows on the prism scales the number of millimetres in thickness through which the light has passed to produce a colour corresponding to that of the water. The results are recorded in the following way—Brown : Blue. Thus 20 : 20 means that the colour of the water, seen through a two-foot tube, was represented by 20 millimetres of brown, and 20 millimetres of blue solution.

It will be observed that the brown tint, noticeable when the water is examined through a stratum of two feet, is more marked during the winter than the summer months. In the case of the New River Company, however, the period during which the brown tint prevails is of exceedingly short duration, the water supplied by this Company to their consumers presenting generally the blue tint characteristic of pure distilled water. Respecting the

* The solutions are made in the following way:—

Brown Solution.—Dissolve ferric chloride and cobalt chloride in distilled water in such proportion that one litre of the solution contains 0.7 gm. of metallic iron, and 0.3 gm. of metallic cobalt. A very slight excess of free hydrochloric acid must also be present.

Blue Solution.—Dissolve 50 grms. of pure crystallised cupric sulphate in one litre of distilled water.

* Report presented to the Right Honourable the President of the Local Government Board, on the Composition and Quality of Daily Samples of Water supplied to London during the year 1881.

brown colouring-matter, however, we would observe: first, that in the water supplied to London, taking the period when the colour is at its maximum, the degree of brown is nothing like so great as is found during the entire year in the waters of the Welsh Lakes (with the characters of which we are well acquainted), and in water of a similar kind, such as that of Loch Katrine, frequently lauded as a pattern water; and, secondly, that there is not the slightest evidence to show that the brown tint, dependent as it is on the presence of a minute trace of peaty matter or of some body resembling it, renders the water either injurious to health or objectionable to taste.

Clearness.

The terms in which we express the clearness or turbidity of a water are arbitrary.

A large bulk of water is poured into a beaker and examined in a good light. Its condition is also observed in the two-foot tube. If a trace of suspended matter be noticeable, we record the water as "turbid." If on close scrutiny we are able to detect any suspended matter whatever, we call the water "very slightly turbid," and we record the water as "slightly turbid" when we consider it to come between those two extremes. Nevertheless, although the terms used are arbitrary, they are to the practised eye definite, and mark with considerable exactness degrees of clearness and turbidity.

Of the 312 samples supplied by the New River Company, 4 were recorded as "very slightly turbid" (two of these being in the month of February), and 308 as clear and bright.

Of the 307 samples supplied by the East London Company, 30 were recorded as "very slightly turbid," and 4 as slightly turbid. All the samples recorded as slightly turbid, and 15 of those recorded as "very slightly turbid," were found amongst the February and March samples.

Of the 315 samples supplied by the Chelsea Company, 13 were recorded as "very slightly turbid," and of these 6 occurred in February and March.

Of the 309 samples supplied by the West Middlesex Company, 4 were recorded as slightly turbid, and 11 as "very slightly turbid." Of these, the 4 slightly turbid samples, and 3 of those recorded as "very slightly turbid" occurred in the month of February.

Of the 313 samples supplied by the Lambeth Company, 5 were recorded as turbid, 15 as slightly turbid, and 25 as "very slightly turbid." Of these, the whole of the 5 turbid samples, 10 of those recorded as slightly turbid, and 9 as "very slightly turbid," occurred in February and March.

Of the 317 samples supplied by the Grand Junction Company, 4 were recorded as turbid, 15 as slightly turbid, and 19 as "very slightly turbid": three of the turbid, 11 of the slightly turbid, and 4 of the "very slightly turbid" samples occurred in February and March.

Of the 308 samples supplied by the Southwark and Vauxhall Company, 4 were recorded as turbid, 6 as slightly turbid, and 29 as "very slightly turbid": 3 of the turbid, 4 of the slightly turbid, and 7 of the "very slightly turbid" samples occurred in the month of February.

It will be seen that a very large proportion of the more or less turbid samples occurred in the months of February and March.

We do not hesitate to say that the water supplied to the Metropolis is, as a rule, efficiently filtered. That an occasional period will occur (such as in the February and March of the past year), when perfect filtration becomes a matter of the greatest possible difficulty, is inevitable. Notwithstanding, however, the exceptionally severe weather experienced in the course of that winter, when pipes were everywhere bursting, and the ground had to be laid open to repair the damage, the number of turbid samples collected were comparatively few, and the extent of turbidity very slight. The suspended matter is almost entirely of the nature of clay and sand, and on the worst days, when the water was recorded as "turbid," averaged considerably less than 1 grain per gallon.

Free Oxygen.

The free oxygen present has been estimated in every sample collected, by a modification of Schützenberger's process.

These estimations of free oxygen in the Thames and Lee have both a scientific and a practical interest. This is the first occasion on which a series of experiments of such extent has been conducted. And the practical truth they convey is, that the waters of the Thames and Lee are well aerated, and contain in solution very nearly the full quantity of free oxygen that it is possible for water to dissolve. This fact is one of great importance as an evidence of the absence of decomposing organic matter; in other words, of the absence either of putrescent or putrescible matter. The late Dr. Miller, of King's College, some years ago pointed out that one of the characteristics of a water charged with obnoxious organic matter was the absence of oxygen in solution; and, on the other hand, that the dissolved oxygen in water of good quality and freely exposed to the air was considerable.

Ammonia and Organic Matter.

The free and saline ammonia has been estimated in a daily sample.

The actual organic matter present has been estimated by determining the oxygen required to oxidise the organic matter, and by combustion. In estimating the oxygen required, we have adopted the method described in detail by one of our number in the *Journal of the Chemical Society* (vol. xxxv., p. 46, 1879); while in the combustion process we have followed the lines laid down by Frankland and Armstrong. The oxygen required to oxidise the organic matter has, since February, been estimated in 7 samples daily, viz., a sample from each Company's supply. The organic carbon and nitrogen have been estimated in one sample daily. We have also given the quantities of oxygen necessary to oxidise the organic matter in the same water.

Hardness.

The initial hardness has been estimated in a daily sample of the water.

We have but one remark to make respecting the mineral matter held in solution in the waters. It consists mainly of the carbonates of the alkaline earths, with a small quantity of sulphates, nitrates, and chlorides. No one suggests that these salts are detrimental to health; and we should be prepared to contend that they are actually useful to the animal economy, as one means of supplying constituents required for the organism.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

March 20, 1882.

MR. ROBERT R. TATLOCK, F.C.S., President, in the Chair.

MR. JOHN CLARK, Ph.D., F.C.S., F.I.C., read a paper on "*The Composition of some Fossil Eggs from the Peruvian Guano Deposits.*"

Some time ago Mr. J. H. M. Fallen very kindly forwarded to me a number of fossil eggs from the Peruvian Guano Deposits, and as I thought their composition might interest this Society, I resolved to lay before you the results of my analysis.

According to information received from Mr. Fallen, the eggs were found in deposit No. 3 on the principal island of the group called the Islands of "Lobos de Afuera," at depths varying from about 2 feet to about 25 feet from the

surface. They are of two sizes, as you will observe from the specimens which I produce, the large eggs being those of the Pelican (*Pelicanus tagus*), called on the Peruvian coast the Alcatraz, and the small eggs those of the Potoyunco or *Puffinuna garnotii*. These eggs appear to differ materially in their composition, and I shall therefore treat of them separately.

Pelican's Egg.—The specimen of the Pelican's egg which I examined was about the size of a goose egg. The shell, of which only a small portion remained, was black in colour, and the interior, which was completely filled, consisted of two materials, corresponding respectively to the "white" and the yolk of the egg. The portion representing the white of the egg formed the bulk of the contents. It was yellowish white in colour, of a somewhat silky lustre, and translucent crystalline appearance. The part representing the yolk was black in colour, and of a somewhat resinous aspect, and formed a very small proportion of the contents. As the quantity of dark-coloured matter in one egg was too small for a proper analysis, I picked out the dark-coloured portions from several eggs, and separated the white as completely as possible.

Potoyunco's Egg.—The interior of the small egg was almost entirely filled with crystals of a somewhat pearly lustre, and contained very little of the black matter corresponding to the yolk.

Analysis of Pelican's Egg.

White Portion.

	Per cent.
Potassium sulphate	34.48
Sodium	10.45
Ammonium	8.70
" oxalate	31.07
" chloride	1.12
" phosphate	2.21
Free acid	trace
Soluble organic matter	2.74
Insoluble	0.93
Calcium phosphate	1.58
Silica	0.02
Water	6.70
	100.00

Nitrogen 9.62

Black Portion from Several Eggs.

Soluble in H ₂ O—	
Potassium sulphate	2.70
Sodium	0.95
Ammonium	1.58
" oxalate	4.95
" chloride	7.08
" phosphate	5.86
Free acid	trace
Soluble organic matter	23.15
Insoluble in H ₂ O—	
Organic matter insoluble in water and ether	16.30
Fatty matter soluble in ether	27.20
Calcium phosphate	3.93
Water	6.30
	100.00

Nitrogen 9.01

Analysis of Shell.

Phosphate of lime	70.33
Oxalate of lime	none
Carbonate of lime, alkaline salts, &c.	29.67
	100.00

Analysis of Potoyunco's Egg.

White Portion.

Potassium sulphate	65.95
Sodium	17.98
Ammonium	10.70
" oxalate	none
" phosphate	1.74
" chloride	0.85
Free acid	trace
Soluble organic matter, &c.	0.40
Insoluble organic matter	0.83
Calcium phosphate	0.56
Silica	0.15
Water	0.84
	100.00

Nitrogen 2.95

When we compare these analyses, the most striking point of difference is the ammonium oxalate, which is present in the large egg to the extent of 31 per cent and absent in the small one.

I am not aware of the exact depth at which the specimens analysed were found, but I am inclined to think that the small egg came from a greater depth than the large one, and judging from the results obtained by Rose and Raimardi, I am of opinion that the proportion of oxalate of ammonium decreases with the depth. The question also very naturally arises, What is the origin of the substances found in the interior of the eggs? The large amount of potash which they contain renders it impossible that the salt can have resulted wholly from an alteration of the original contents of the egg, and they must be derived in part at least from infiltration, which probably takes place by a species of endosmosis. We know at any rate from the investigations of Chevreul that oxalate of ammonium and potash salts are normal constituents of Peruvian guano, and according to Shephard there is a mineral, which he has called guanapite, found in rounded masses and veins in the Peruvian deposits, which consists of sulphate of potassium, sulphate of ammonium, and a small quantity of oxalate of ammonium; so that we have no difficulty in tracing the source of at least a great portion of the constituents of these eggs to the guano itself.

Mr. T. N. WHITELAW read a paper on the "Action of Ammonia on Fats at a High Temperature."

In the ordinary way of conducting the hard soap manufacture, a considerable amount of glycerin will remain mixed with the soap after the first running of spent lye, and from the great bulk of the soap a second washing, while giving a dilute glycerin with a relatively large quantity of salt, will still leave glycerin far from perfectly removed. Again, in the soft-soap manufacture the glycerin is left in the soap, where it probably serves no useful purpose, as a good soft soap can be made free from glycerin.

Considering such points it appears desirable to find some process by which the glycerin may be removed from the fats before beginning the soap manufacture. The decomposition of the fats by ammonia seemed a possible method of obtaining glycerin readily in a pure state, and the following experiments were undertaken to see if the fats, after treatment with ammonia at a high temperature, were in a condition suited for the manufacture of soap.

One part of cotton-seed oil was heated in a sealed tube with rather more than an equal volume of strong aqueous ammonia. After continued heating to 100° C., no distinct decomposition seemed to take place, but after twenty-four hours, with repeated agitation, the bulk of the oil came to the surface apparently unaltered. Even up to 110° C. there was no marked effect, but from 110° to 120° the oil became decomposed with comparative rapidity, and a clear amber-coloured thick liquid took the place of the previously-turbid mixture of oil and ammonia, indicating clearly that decomposition was complete. When

cold this appeared as a soft, yellowish white, opaque, soap-like mass. On heating for two or three hours in the water-bath, the ammonia was driven off, and an oily substance left, with a distinct sweet taste, which on washing yielded glycerin. The washed oil was heated with water, and weak caustic soda solution added, drop by drop, when combination took place, and a soap-like body formed, but in presence of a very slight excess of caustic soda the soapy compound was rendered insoluble, and coagulated into a tough mass.

A similar insolubility was observed in presence of a trace of common salt or carbonate of soda. This at once showed that the oil was different from or linary fatty acids, of which the soaps are more soluble in dilute caustic soda or salt solutions than in water. On adding considerable excess of caustic soda and boiling, no change took place until the solution became concentrated, when evolution of ammonia occurred, becoming copious on fusion. By this process, although the glycerin is readily obtained, the oil is darkened in colour, and so modified as to be unsuited for soap making; and the operation of driving the ammonia off by fusion with caustic soda seems difficult and impracticable.

The change in the oil seemed to be due to the formation in some quantity of amides of the fatty acids, similar to those first examined by Bouillay in 1843, and further experiments were undertaken to find if this were really the case. The previous production of those amides was by digestion of the oils for some months with aqueous or alcoholic ammonia, and Carlet had only with the solid fats used the temperature of the water or salt-water bath, in which case he took from fifteen to twenty days to get complete decomposition.

In my experiments, "tallow cake," "palm oil," "cotton-seed oil," "rosin," and "crude palmitic acid" were heated to 120° C., as previously described, with 1 to 1½ volumes of aqueous ammonia, and in each case within from three to six hours a distinct change from turbid mixture to clear soap-like solution, indicated the completion of the reaction.

In the cases of almond oil and cotton-seed oil, where the ammonia was perhaps more distinctly in excess, after four to five hours heating a separation into two layers seemed to indicate undecomposed oil, but on closer examination both layers were found to be quite clear and soap-like, the separation being due probably to the insolubility of the amide in aqueous ammonia. On cooling, the ammonia (of which the greater portion seemed to be combined with fatty acids as ammonia soap) was neutralised with weak hydrochloric acid, and the oil obtained clear by boiling, washed, and dissolved in alcohol.

In the case of tallow cake, the melting-point of the modified oil was 28° C. higher than that of the corresponding fatty acids obtained by saponification of the tallow cake with soda and decomposing with acid. The solutions of the oils from "tallow cake," "palm oil," and "cotton-seed oil" on cooling, deposited white crystalline nodules, which, when purified by several crystallisations from alcohol, had the following melting-points (taken in a capillary tube suspended with thermometer in water, which was gently heated):—

Tallow, stearamide	101° C.	} Probably still impure.
Palm oil, palmitamide	96	
Cotton-seed oil, ?	98	

Being sufficiently near to Carlet's melting-points of 107·5° for stearamide and 101° for palmitamide if allowance is made for the different methods employed in taking them. The properties of those bodies correspond with the amides described by Bouillay, 1843, Bowney, 1855, and Carlet, 1859. Insoluble in water, soluble easily in hot alcohol, crystallising from it in white nodules, not decomposed by boiling solution of caustic soda, but decomposed by fused caustic soda with evolution of ammonia.

The solution of modified almond oil in hot alcohol did not give any crystals, though other indications of the

presence of an amide were given; and I have failed to get any body corresponding to oleamide.

The palmitic acid heated with ammonia seemed to yield simply "ammonia palmitate," as palmitic acid was recovered from it unchanged. Rosin was darkened in colour and modified in odour, but did not seem to be otherwise altered in properties.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, April 3, 1882.

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair

Benjamin Baker, M.I.C.E., and William Edmund Rich, M.I.C.E., were elected members of the Royal Institution.

The Presents received since the last Meeting were laid on the table, and the thanks of the Members returned for the same.

Candidates for Membership were proposed for election.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 14, April 3, 1882.

Haloid Salts of Silver and Potassium.—M. Berthelot.—In this memoir the author continues his thermochemical studies on the double iodides, bromides, and chlorides. He concludes that the displacement of hydrochloric acid, when combined with silver oxide, by hydrobromic and hydriodic acids, free or combined with alkalies, is effected easily and in a preponderating manner by reason of the thermic preponderance of the two latter acids.

Combination of Free Hydrogen with Ethylen.—M. Berthelot.—The author has formerly shown (*Annales de Chimie et de Physique*) that free hydrogen combines with ethylen at a dark red heat, but only to a small extent. By operating at a lower temperature, and for a longer time, the author has succeeded in pushing the combination up to 70 per cent. Secondary products were almost entirely absent.

Specific Heat of Hyponitric Gas.—MM. Berthelot and Ogier.—The authors made measured the entire heat given up by this gas between 200° and 26° and between 100° and 26°. They deduce for the mean molecular specific heat (referred to the weight 46 grms.) between 100° and 200° the value +17·4, which is higher than the sum of the specific heats of oxygen and nitrogen. The specific heat of hyponitric gas, contrary to what is the case with the gases previously studied, is much greater between 100° and 26° than between 200° and 100°.

Researches on the Passage of Electricity through Rarefied Air.—E. Edlund.—The author concludes from his experiments that neither highly rarefied gases nor a vacuum can be an insulator.

Solar Apparatus.—A. Crova.—Under this name the author understands arrangements for obtaining mechanical power from the sun's rays. He considers that, except in very dry and hot climates, these devices cannot be practically applicable.

Heat due to Magnetisation.—M. Pilleux.—The author has heated to above 200° the iron core of an electromagnet by causing it to be traversed by the alternate currents of a Mériten's machine. On substituting for the iron cores of non-magnetisable metals of different degrees of

conductibility the heating was not produced. On operating with iron of different degrees of temper, and even with steel, he finds that the coercitive force of the cores increases the heating when they undergo the action of frequent magnetisations and demagnetisations. It is therefore to the magnetisation and not to induction currents that the considerable heating of electro-magnets in certain cases must be attributed. The coercitive force plays the same part as the resistance to the passage of electricity when a wire is heated by the current of a battery.

Absorption Spectrum of Pernitric Acid.—J. Chapuis.—Pernitric acid cannot be prepared free from ozone. Fortunately, the bands of pernitric acid are more intense and their character is very distinct. Traces of this body show two lines between D and A, in a region where ozone presents no bands. Moreover, the rays are fine and black, in place of the broad grey bands with indistinct outlines, which characterise ozone. The author describes 8 rays, of which Nos. 1 and 4 are the blackest, most definite, and most characteristic. No. 3 is grey, and does not seem to separate itself from No. 4. Nos. 6 and 7 are superimposed on band 2 of ozone. Band 8 is superimposed on the two rays D. Nos. 2 and 5 are very fine.

Electrolysis of Distilled Water.—D. Tommasi.—The author proves experimentally that, contrary to the statements of several physicists, and especially of M. Bourgoin, pure water is capable of electrolysis, even by the current of a very weak battery, provided that the calories liberated by such battery are at least equal to the calories absorbed by the water on decomposition into its elements.

Determination of Nitric and Nitrous Acids as Ammonia.—A. Guyard.—The author's method is based on the fact that in presence of marsh-gas and soda-lime at a red heat the nitrogen oxides, whether free or combined with alkalis or the nitric oxides of organic matters, are totally converted into ammonia. The manipulations are identical in all points with those required by the processes of Peligot, Will, and Varrentrapp. The author mixes intimately 5 grms. sodium acetate previously dried and 45 grms. of soda lime. Of this mixture 10 to 15 grms. are introduced at the bottom of the combustion-tube; this portion is intended to sweep out the ammoniacal gas by means of a current of marsh-gas. With the 35 to 40 grms. of the mixture remaining there is mixed 0.4 to 0.5 gm. of the nitrous compound. The whole is introduced into the tube, which is then filled up with ordinary soda lime, and the combustion is carried out as in an ordinary determination of ammonia. This process gives the whole of the nitrogen existing in different forms as ammonia. To determine in a sample the nitrogen in its three principal forms, three determinations are needed:—1. Determination of ammoniacal nitrogen with soda lime and calcium oxalate. 2. Determination of total nitrogen by the process above described; the difference gives the nitrogen present in nitric acid. 3. Determination of total nitrogen in a portion of the sample previously freed from nitrous acid by evaporation in the water-bath with an excess of acetic acid. The difference between No. 1 and No. 3 shows the nitrogen present as nitrous acid.

Effects of Compression upon the Hardness of Steel.—M. Lan.—Compression produces upon cast-iron and steel the same physical and chemical effects as sudden refrigeration.

Composition of Hydrated Carbonic Acid.—S. Wroblewski.—At the temperature of zero, and under a pressure of 16 atmospheres, hydrated carbonic acid is composed of 1 equiv. of carbonic acid (carbon dioxide) and 8 equivs. of water.

Ammonium Bisulph-hydrate and Cyan-hydrate.—M. Isambert.—Hydro-sulphuric acid and ammoniacal gas exert the same pressure in a mixture, whether they are free or combined, the pressure of each gas being inversely as that of the other. As regards the ammonium hydrocyanide, the tensions of hydro-cyanic acid and of ammo-

nium hydro-cyanide increase regularly with temperature. The tensions of the hydro-cyanide in presence of an excess of free hydro-cyanic acid are the same as those of hydro-cyanic acid alone.

Action of Sulphuretted Hydrogen upon the Saline Solutions of Nickel and the Metals of the Same Group.—M. Baubigny.—Not merely nickel and cobalt, like zinc, may be completely precipitated from the solutions of their chlorides and sulphates, but even iron is partially thrown down. Among the metals capable of yielding an insoluble sulphide, the only one which is not thrown down by sulphuretted hydrogen from the solutions of its chloride and sulphate is zinc. Its acetate, like those of cobalt, nickel, and iron, gives a precipitate of sulphide. The discrepancies in the statements of different authorities are due to variations in the conditions of the experiment; in the degree of dilution of the liquid, of the neutral salt and water; the nature of the acid of the salt; the relation of the weight of the acid and the base and of the free acid and the water; the temperature; the duration of the operation, and other conditions. The two following experiments are noted:—(1) To 0.2284 gm. neutral nickel acetate were added 9.29 grms. of monohydrated acetic acid, or 60 times the weight of the acid in the salt. (2) To 1.256 gm. of the same acetate were added 17.03 grms. monohydrated acetic acid, or 20 times the weight of the salt. The liquid in each flask was made up with water to 140 c.c.; it was saturated with sulphuretted hydrogen at 0°, and the flasks were then sealed and left at the temperature of the atmosphere, +12°—16°. In flask No. 1 there appeared no precipitate after the lapse of twenty-four hours, whilst in No. 2, containing the greatest weight of free acid for the same weight of water, the precipitate was distinct in an hour, and went on increasing. The liquid, which was green at first, had become colourless at the end of twenty-four hours. Only 0.0115 gm. of the nickel sulphate had escaped precipitation.

Ammoniacal Zinc Chlorides.—G. André.—A thermochemical study. The author gives the quantities of heat liberated in the formation of these compounds.

Hydrate of Hydrogen Sulphide.—M. de Forcrand.—The composition of this hydrate is given approximately as $HS + 15HO$. It is more stable than many similar compounds.

Synthesis of Quinine.—E. J. Maumené.—The discovery of H_2N has given the author the means of effecting this synthesis. He will shortly communicate to the Academy the details of the very simple operation in which H_2N yields very pure quinine sulphate. He is about submitting his product to therapeutic studies.

Action of Fuming Nitric Acid and Hydrochloric Acid upon Pilocarpine.—P. Chastaing.—Pilocarpine is easily converted into jaborandine by the action of excess of fuming nitric acid, and in small quantities by the action of hydrochloric acid in presence of oxygen.

Gastric Microzymas and Pepsine: Remarks on M. Gautier's Note of March 6th.—A. Béchamp.—The author calls in question the nature of the particles observed by M. Gautier.

Existence of Products Analogous to the Ptomaines in the Gastric and Pancreatic Digestions of various Albumenoid Matters.—J. Béchamp.—The author shows that several albumenoid matters possess certain properties of the ptomaines. In the normal processes of digestion there are formed substances possessing similar characters,—notably that of reducing potassium ferricyanide—and approaching closely to the poisonous alkaloids in their chemical reactions.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., January, 1882.

History of the Discovery of the Speaking Telephone of M. Graham Bell.—M. le Comte du Moncel.—It is

demonstrated that Mr. Bell first made the telephone speak by applying to it continuous and undulatory currents, a function of the vibrations of the voice, and solved the problem whether with the induced currents resulting from the vibrations themselves of the transmitter, or by the variations of the resistance of an imperfect conductor placed in connection with a voltaic circuit and themselves resulting from the vibratory effects. A fact curious enough to be reproduced here is that, in 1865, Mr. Yeates, of Dublin, in endeavouring to improve the telephone of Reiss, realised to some extent the liquid transmitter of Bell and Gray, for he introduced between the platinum contacts of Reiss's apparatus, a drop of water, which rendered it fit for the reproduction of articulate sounds.

Universal National Exhibition of 1878.—Colouring Matters and Colours.—M. Lauth.—This summary would have been very valuable if published two or three years ago.

Journal de Pharmacie et de Chimie.
February, 1882.

Action of Monohydrated Nitric Acid upon Morphine: Production of Picric Acid.—P. Chastaing.—This production of picric acid shows that the definition of the alkaloids given by Kœnigs—organic vegetable bases which are pyridic derivatives—is too absolute, and proves the existence in morphine of an aromatic nucleus, though there is room to believe that a pyridic nucleus may exist along with the aromatic nucleus.

Certain Critical Observations on the Volumetric Determination of Phosphoric Acid by means of Uranium Solution.—G. Guérin.—This method, first proposed by Neubauer for the determination of phosphoric acid in urine and favourably received at first by most chemists, has not yet taken rank among exact scientific methods on account of the irregular results obtained in attempting to generalise its use. Neubauer remarked very judiciously that sodium acetate retards the action of potassium upon the uranium liquid, and hence he recommends that all the determinations should be executed under the same conditions as the preparation of the standard solution. But sodium acetate is not alone in producing this effect; almost all ammoniacal salts have a similar action, and ammonium acetate in a moderately concentrated solution completely prevents the precipitation of uranium ferrocyanide. Hence follows the impossibility of obtaining by this method an exact volumetric determination of the phosphoric acid contained in urines which have undergone the ammoniacal fermentation. It is the same with phosphoric acid, isolated as authors recommend, as ammonium magnesium phosphate, and re-dissolved in acetic acid. On the other hand, certain chemists have found that the titration of phosphorites by this method gives results too low, and explain this fact by the entanglement of a little calcium phosphate by the uranium phosphate precipitated. Hence the precaution in such cases of fixing the standard of the solution, not by sodium, but calcium phosphate. Hence we consider Neubauer's method as little adapted for the direct determination of the phosphoric acid in urines, where it exists in the state of various phosphates. We believe that its use requires in a general manner that the value of the uranium solution should be determined by means of the same kind of salt to be determined, the presence of ammonium acetate being absolutely avoided.

Presence of Phosphorus and Iodine in Cod Liver Oils.—P. Carles.—When these oils are neutral and well filtered, iodine and phosphorus are absent. When the oils are acid these bodies are found, according to the degree of acidity, in milligrammes and tenths of milligrammes.

Determination of Alkaloids in Cinchona Barks.—M. Flückiger.—The author boils 20 grms. of the bark, finely powdered, with 80 grms. of water. To the cold decoction is added a milk of lime consisting of 5 grms.

lime and 50 grms. water. The mixture is evaporated in the water-bath until it is converted by constant stirring into little clots. With this mixture he fills a continuous exhaustion apparatus, consisting of a tube of glass 24 centimetres in length, 15 of which are filled up with the mixture, which rests upon a disk of brass pierced with little holes, and covered with a circular piece of filter-paper. This exhaustion apparatus is secured to a small flask containing ether, and heated in a water-bath at a constant temperature. The complete exhaustion of the mixture of bark and lime is ascertained by collecting a few drops of ether coming from the percolator, and adding to them an equal volume of a solution of 332 milligrams. potassium iodide and 434 milligrams. mercuric iodide in 100 grms. water. The solution ought not to become turbid. At the end of the operation the flask which contains the quinine dissolved in ether receives 36 c.c. of a decinormal solution of hydrochloric acid (3.65 grms. HCl per litre). The ether is distilled, and hydrochloric acid is again added until the solution becomes acid. It is then filtered, and to the cold liquid is added 40 c.c. of a decinormal soda solution (4 grms. caustic soda per litre). The supernatant liquid is allowed to stand till it becomes clear, and there is then added to it soda-lye at specific gravity 1.3 till no further precipitate is produced. The precipitate is washed upon the filter with cold water until the washings no longer cause any turbidity in a clear solution of quinine sulphate saturated in the cold. The precipitate is pressed between leaves of filter-paper, and dried in the air. It is then detached from the paper, dried on a watch-glass over sulphuric acid, and lastly in the water-bath at 100°. The product should be at least 600 milligrams. if the bark contains 3 per cent of alkaloids. But this precipitate is not pure quinine. To estimate the proportion of other alkaloids the quinine obtained is boiled in thirty times its weight of water for an hour and filtered. On cooling quinine hydrate is deposited. To 5 parts of the decanted liquid there is added 1 part of chlorine water and a drop of ammonia. If it is quinine a fine green colour will be produced. The dry alkaloid is soluble in twenty times its weight of ether if it is pure quinine.

Moniteur Scientifique, Quesneville.
March, 1882.

Cotarnine.—E. von Gerichten.

Codeine.—Same author.

Morphine.—MM. von Gerichten and Schrötter.

Trimethylenic Alcohol and Trimethylene.—August Freund.—These four papers are translations from *Liebig's Annalen* and from the *Berichte der Deutschen Chem. Gesellschaft*.

Preparation of Compounds of Cæsium and Rubidium.—Dr. Karl Settarberg.—Already noticed.

"Disinfection" of Alcohols of Bad Flavour.—L. Naudin.—Already noticed.

Industrial Society of Mulhouse.—Meeting of Feb. 8th.—MM. Schæffer and Dollfus reported on their examination of the decolourised blood albumen of Hofmeyer and Co. It dissolves in water without residue, but it becomes slightly coloured on steaming; more than egg-albumen though less than the ordinary blood-albumen. M. Schæffer reported that jute bleached on the principle of Cross and Bevan is much less darkened by steaming than that done by the old process.

Chloroform as an Anæsthetic.—M. Yvon.

New Method of Purifying Chloroform.—M. Yvon.

Observations on Chloroform intended for Anæsthetic Purposes.—M. Regnaud.—These papers are taken from the *Journal de Pharmacie et Chimie*.

Applications of Tannin.—Juste Kœchlin.—Reserved for insertion at length.

Fixation of Alumina as a Discharge on Indigo-Blue by means of Aluminium Chloride.—G. Saget.—Reserved for insertion at length.

Researches on Atropine.—Dr. L. Pesci.—From the *Gazzetta Chimica Italiana*.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 1, January and February, 1882.

This issue contains no original chemical matter.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 9, 1882.

Stability of Cupric Hydrate.—D. Tommasi.—The author gives his results in a tabular form. A solution of manganese sulphate at 0.30 per cent prevents cupric hydrate from losing its water, even if heated to 100°.

Medical Electricity.—This paper cannot be intelligibly reproduced without the five accompanying illustrations.

Illumination of Conservatories by the Electric Light.—The naked rays of the electric light were found injurious; after passing through glass globes they ceased to have any hurtful action upon plants, but their efficacy was not great. Nocturnal illumination is not fatal to plants, but there is no proof that it is beneficial. Upon the whole the results obtained at the Palace of Industry are not favourable.

No. 10, 1882.

A Summary of the Procedures for Preventing the Oxidation of Iron and Steel.—An account of the arrangements of a company formed for utilising the inventions of Barff and Bower, the ultimate credit of which is ascribed to Lavoisier.

The Arrangement of a Manganese Battery the Salts of which are Regenerated.—J. Rousse.—The battery in question is a Bunsen, in which the zinc is replaced by ferromanganese, containing 85 per cent of manganese. M. Rousse also proposes a nickel battery in contact with sulphuric acid or ammonium sulphate. He also uses, instead of the zinc in a Bunsen battery, an alloy of zinc and antimony, known as Crookes's alloy.

No. 12, 1882.

Extraction of Zinc by Electricity.—An account of the Létrange process applied to blende.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 2.

Changes and Effects of Water in Irrigation.—J. König and C. Krauch.—This memoir gives a comparison of the systems of Petterssen, Abel, and Vincent, and the common superficial system. As regards the manurial action of the water, the absorptive power of the soil is less important than the precipitation of suspended particles, and the direct reception of the dissolved nutritive matter by the plants. The only plant-food retained by the soil itself is potash. The water employed does not seem to have been sewage.

Composition and Use of Falasco.—Prof. F. Sestini.—Falasco is a mixture of swam-plants, used in Italy as manure.

Manurial Experiments on Barren Heath-Soils.—Prof. A. Meyer.—The cost of manuring was in no case compensated by the increased yield. Plots left unmanured and those which received only potassium chloride yielded substantially nothing. After bone-dust the harvest was little better. The addition of peat-earth and of green manures gave the best result.

Presence of Phosphoric Acid in the Urine of the Herbivora.—Dr. de Leeuw.—The channel through which phosphoric acid is excreted depends on its relative proportion to the lime in the food.

Digestibility of Certain Foreign Oil Cakes.—E. v. Wolff.—The author assigns the first rank to earth-nut cake (*Arachis hypogaea*); then follow cotton-seed, sesame, and sunflower seed cakes. Cocoa-nut cake approaches more to palm oil cake.

Influence of Space upon the Development and the Yield of Crops.—Prof. E. Wollny.—A very extensive memoir, from which it appears that the quality of grain is best when the plants stand sparsely. In root-crops the roots or tubers are within certain limits larger, the larger the space allotted to each plant. The production of plants in general increases with the size of the space, that is, the seed reproduces itself in a higher ratio. Want of room deprives plants of a sufficiency of light, heat, and moisture, and promotes the action of parasites.

Milk and its Analysis.—In determining the moisture in milk, Marpmann proposes to place it upon cotton-wool in a chloride of calcium tube and draw warm air over it. The moisture is expelled in ten to fifteen minutes, and the fat may be extracted from the dry residue by means of benzol. The cotton-wool must have been previously freed from grease.

Bulletin de la Société Chimique de Paris.
Tome 37, No. 5, 1882.

Chromic Acid and the Chromates.—Maurice Prudhomme and F. Binder.—The authors give two formulæ to represent the double decomposition between potassium bichromate and the salts of the diatomic metals. In case of the salts of barium there are formed neutral barium chromate, potassium chloride, and free chromic acid, which is easily detected by means of barium peroxide and ether. The solution of chromic acid in addition to potassium chloride can contain merely barium chloride or potassium bichromate, but after a time it deposits a small quantity of neutral barium chromate, previously held in solution. In Warington's process for preparing chromic acid by means of potassium bichromate and sulphuric acid, an excess of barium bichromate is added to eliminate the excess of sulphuric acid and potassium bisulphate. But this body is possibly produced by the action of chromic acid upon the neutral chromate, but not by double decomposition, and the process of purification seems open to criticism. This method of preparation is a new proof in support of the constitution of potassium bichromate, which may be considered as a molecular compound of neutral chromate and chromic acid easily displaceable.

Action of Time upon Ferric Hydrate.—D. Tommasi and G. Pellizzari.—Already noticed.

Stability of Cupric Hydrate.—D. Tommasi.

A New Class of Borotungstates.—D. Klein.—The author has obtained and analysed the boro-quatuor-decitungstates of sodium (disodic), barium, potassium, silver, as also certain double salts.

Quinoleine derived from Cinchonine.—E. Schaner de Coninck.—The quinoleine obtained has a pleasant odour; its density at 0° = 1.1055; under a pressure of 775 m m. it boils at 236° to 237°. The boiling temperature of synthetic quinoleine is variously stated at 228° and 232°.

No. 6, 1882.

This issue contains no original communications.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. March, 1882.

This part contains no chemical papers.

MISCELLANEOUS.

Royal Institution.—The following are the probable arrangements for the Friday Evening Meetings after Easter :—

April 21st.—Prof. Dewar, "Experimental Researches of Henri Ste.-Claire Deville, Hon.M.R.I."

April 28th.—Prof. Abel, "Some Dangerous Properties of Dusts."

May 5th.—Prof. R. Grant, "The Proper Motions of the Stars."

May 12th.—A. G. Vernon Harcourt, "The Relative Value of Different Modes of Lighting."

May 19th.—Sir Frederick Bramwell.

May 26th.—Sir Henry S. Maine, "Sacred Laws of the Hindus."

June 2nd.—H. H. Statham, "The Intellectual Basis of Music."

June 9th.—Prof. Burdon Sanderson, "The Excitability of Plants."

MEETINGS FOR THE WEEK.

MONDAY, 24th.—Medical, 8.30.
Philosophical Club, 6.30. (Anniversary.)

TUESDAY, 25th.—Institute of Civil Engineers, 8.

Royal Medical and Chirurgical, 8.30.

Royal Institution, 3. "History of Customs and Beliefs," by Dr. E. D. Tylor,

Society of Arts, 8. "The Character and Social Industries of the Inhabitants of China, Japan, and Formosa," by Lieut. the Hon. Henry N. Shore.

Anthropological Institute, 8. "Exhibition of Pottery from Silesia," by General Pitt Rivers, F.R.S. "On the Aboriginal Inhabitants of the Andaman Islands, Part II.," by E. H. Man.

WEDNESDAY, 26th.—Geological, 8.

Society of Arts, 8. "Telephonic Communication," by Lieut.-Col. C. E. Webber, R.E.

London Institution, 12. (Anniversary.)

THURSDAY, 27th.—Royal, 4.30.

Royal Institution, 3. "The Metals," by Prof. Dewar.

Society of Arts, 8. "The Manufacture of Steel from Phosphoric Pig-iron," by S. G. Thomas, F.C.S., and Percy C. Gilchrist, F.C.S.

FRIDAY, 28th.—Royal Institution, 8. "Some Dangerous Properties of Dusts," by Professor Abel, at 9 p.m.

Society of Arts, 8. "National Necessities as the Bases of National Education," by Dr. Richardson, F.R.S.

Quekett Microscopical Club, 8.

SATURDAY, 29th.—Royal Institution, 3. "History of the Science of Politics," by Mr. F. Pollock.

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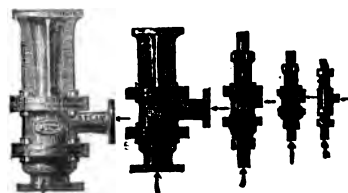
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THE CHEMICAL NEWS.

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22 APR 32

ON CRYSTALLISED ANHYDROUS
GRAPE-SUGAR.

By ARNO BEHR, Ph.D.

ANHYDROUS grape-sugar in a state of purity has so far only been obtained from an alcoholic solution. Two years ago F. Soxhlet found that the best solvent for it is methylic alcohol, from which much larger and better developed crystals can be obtained than from the solution in ethylic alcohol. I have found that it can even more easily be prepared from a watery solution.

The principle that a crystal introduced into the super-saturated solution of the same substance induces crystallisation, has long been applied to the practice of grape-sugar manufacture. In order to hasten the hardening of the sugar, a certain quantity of the already hardened sugar of a previous operation is stirred into the mass. But as the ordinary commercial grape-sugar always contains the hydrate, the crystallisation so obtained is also that of the hydrate. I put the question to myself, What would happen if, instead of the hydrate, I introduced the crystallised anhydrous sugar into a concentrated solution of ordinary grape-sugar. I tried the experiment and must confess that I had not much hope that anything else but crystallised hydrate would be the result, for I expected to see the anhydride transformed into the hydrate within the watery solution. I was agreeably surprised when, on the next morning, I found the glass filled with a neat crystallisation of anhydrous grape-sugar, from which the liquid part could be easily drained. The few crystals of anhydride, far from being transformed into the hydrate, had induced an ample crystallisation of their kind. The explanation of this fact is found in the following:—In its crystalline form anhydrous grape-sugar is not deliquescent, even in very moist weather, and it is stable in comparatively dilute solutions of grape-sugar. I have kept crystals exposed to the atmosphere of the laboratory for months and during moist weather without seeing them lose their sharp outlines and bright appearance, and I have repeatedly found the syrup drained from a crystallisation of anhydrous sugar to contain as much as 26 per cent of water. The limits of concentration, within which this crystallisation can be obtained, are rather wide, but in order to secure a good result the solution ought to contain from 12 to 15 per cent of water. It is well not to allow the mass to cool rapidly or the temperature to fall much below 30° C.; for at a lower temperature, and before the remaining syrup has been diluted by the separation of the anhydrous crystals, concentrated solutions are rather viscous, and this viscosity prevents a free crystallisation. A good temperature is 30° to 40° C. The time within which the crystallisation is completed varies between half a day and several weeks, according to the purity of the mass.

Though it is always well, in order to secure a uniform and speedy crystallisation, to start it by the introduction of some crystals, yet it is possible, and, for sugars of high purity, quite easy, to obtain the same crystallisation by simply keeping the concentrated solutions at a temperature of about 30° C. for some time. Under these circumstances a crystallisation of anhydrous grape-sugar takes place. This behaviour of grape-sugar is also unexpected. Soxhlet, who, a short time ago, took out patents in different countries for the refining of grape-sugar by means of alcoholic liquids, and for the production of a hard crystallised grape-sugar, describes one of his products expressly as the hydrate of the formula $C_6H_{12}O_6 + H_2O$; yet he con-

centrates highly a solution of very pure grape-sugar, and allows it to crystallise at an elevated temperature. I have failed, under the conditions of my experiments, to obtain the hydrate, but that it is possible for the hydrate to crystallise in large and well-developed crystals has been established in 1877 by Halse and Steiner, who analysed a crystallised hydrate of grape-sugar, of which some crystals weighed 4 to 5 grms., and which was readily taken for cane-sugar. This grape-sugar had made the voyage from England to Australia and back, and during this time had undergone the transformation.

A product which has for some time played an important part in the literature of this subject, is Anthon's hard crystallised grape-sugar. As early as 1857, Anthon, in Prague, prepared a very pure sugar by crystallising and pressing the hydrate. He then melted the press-cakes without addition of water, and allowed the mass to solidify in moulds. He obtained crystalline masses, which, according to his analysis, contained 4.7 per cent of water, and for which he claimed the constitution of a half hydrate of grape-sugar of the formula $2(C_6H_{12}O_6) + H_2O$. As he did not drain his crystals, he certainly had nothing but a mixture of anhydrous sugar and the hydrate, the surplus water of the hydrate having been evaporated during the melting. This has already been suggested by Stohmann in the latest German edition of "Muspratt's Chemistry," (vi., 2077).

Crystallised anhydrous grape-sugar, such as I have prepared from a watery solution, has the following properties:—Dried at 30° to 40° C., it does not retain more than 0.2 per cent of moisture, the moisture determination being made at 130° C. It shows a neutral reaction with sensitive litmus-paper. It melts in a capillary tube between 141° and 145° C. It was tested in the polariscope, and showed bi-rotation. Landolt in his book on the optical rotatory power of organic substances ("Braunschweig," 1879, p. 184) gives 32.68 grms. as the amount of pure grape-sugar, which, taken instead of the normal weight of cane-sugar, should show 100 on the scale of a Ventske-Soleil instrument. It was found that, if this amount was rapidly dissolved in cold water and immediately polarised, it showed a polarisation varying between 202 and 204; if it was allowed to stand for twenty-four hours, 101 to 102. This difference is mainly due to an error in Landolt's figure. This figure is calculated from an assumed specific rotation of $\alpha_D = 53.0$. This is correct only for a concentration of 10 grms. of sugar in 100 c.m. of solution; but for a concentration of 32.68 grms. in 100 c.m., α_D becomes $= 53.57$, according to Tollens's determinations. Therefore, 32.68 grms. ought to polarise 101.1, while the observed polarisation for mono-rotation was 101 to 102.

These are the facts so far as they refer to chemistry; but in view of the increasing importance of grape-sugar as an article of general consumption, I wish to add a few remarks with reference to the industrial application of these observations.

In the ordinary process of the manufacture of grape-sugar from starch the conditions are such that the resulting product is always far from being pure grape-sugar, however pure the starch from which it was derived may have been. Though a good method for the quantitative determination of starch consists in its conversion with a mineral acid and subsequent determination with Fehling's solution, yet in practice a smooth and complete conversion is not attainable. The reason for this difference lies in the fact that the chemist, for a complete conversion, works with a very diluted solution, while the manufacturer necessarily works with solutions of higher density. At a higher density, however, the acid seems to act on the sugar already formed, and before all the dextrin is converted into sugar the sugar itself is partially converted into something else, which constitutes an impurity of the final product. So far we know very little about the nature of these impurities of commercial grape-sugar, but several chemists have asserted that the residues which remain after fermentation and distillation are more or less in-

urious to the human system. This subject, though, requires a more complete investigation. As the principal use of all the grape-sugar produced is that which is made of it in the manufacture of fermented beverages, beer, and wine, it is easy to understand the rising demand for a purer article.

F. Anthon has, twenty years ago, called attention to the disadvantages arising from the use of impure grape-sugar in wine-making, and suggested a remedy. His suggestion was to refine the ordinary grape-sugar by crystallisation, and the use of a centrifugal machine for the removal of the liquid impurities. He modified this process in so far as he used a strong press instead of a centrifugal machine, and according to the testimony of several chemists really produced an article of remarkable purity. His process seems to have never been used for any length of time on an extensive scale.

Fouchard had already, in 1853, manufactured a refined grape-sugar by allowing grape-sugar solutions to crystallise in barrels, and then withdrawing the liquid portion through a number of holes in the bottoms of the barrels.

Though the principle of these refining processes is correct, yet there is a difficulty inherent in it, which arises from the form and nature of the crystals in which the sugar solidifies. Under ordinary circumstances grape-sugar crystallises from a watery solution as the hydrate in the shape of very fine tablets, which are mostly grouped spherically. Owing to the fineness of the tablets and the capillary attraction it is difficult to remove the impure mother-liquor sufficiently from the crystals by means of a centrifugal machine, and even with a hydraulic press high purity cannot be obtained together with a large yield. It is different with the crystals of anhydrous grape-sugar. They are of a prismatic shape, and form loose aggregations, from which the syrup can be easily removed by centrifugal force, and which lend themselves to a treatment of draining and washing very similar to that of cane-sugar. Under these circumstances it is possible to produce a grape-sugar which compares in purity with block and granulated cane-sugar. A number of applications for such an article readily suggest themselves. The confectioner, the druggist, the manufacturer of condensed milk may use it. In the preparation of certain wines it can safely take the place of cane-sugar, but its principal use ought to be in the kitchen for all those preparations where utmost sweetness is not sought for. It is not so well suited for tea or coffee, though it does not quite so unfavourably compare with cane-sugar, as the books will have it. To obtain a moderate sweetness, equal to that produced by a given amount of cane-sugar, it is not necessary to take two-and-a-half or three times as much as cane-sugar, but only about one and two-thirds times the quantity; at least I have found it so, and so have some of my friends.

Jersey City, April, 1882.

LONDON WATER SUPPLY.*

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington; and late
Deputy Medical Officer of Health for the City of London.

(Concluded from p. 171.)

GENERAL CONCLUSIONS.

ALTHOUGH any conclusions that we have ourselves drawn from the large body of facts we have placed before you, would, in whatever form expressed, receive doubtless that measure of consideration to which their greater

or less accordance with the facts would entitle them, yet inasmuch as the conclusions to which we have come in 1881 are in complete agreement with those arrived at by the Royal Commission on Water Supply, who made their report in 1869, we prefer, in view of a possible imputation of personal bias, to express our conclusions in the form of extracts from that report, rather than by the use of any language of our own. This Commission, which was presided over by the Duke of Richmond, consisted, in addition, of the then Chairman of the Metropolitan Board of Works, of an Alderman of the City of London, and of three eminent professional men. Their report, we would remind you, constitutes the most recent report having a judicial character* which has been made on the subject of Water supply; and its conclusions are entirely at one with those of a previous report made by a Committee of the House of Commons, appointed to enquire generally into the operations and results of the Metropolis Water Act, 1852.

Extracts from the Report of the Royal Commission on Water Supply.—1869.

Par. 128.—“This Committee (that of the House of Commons), of which Mr. Ayrton was Chairman, inquired fully into the whole subject, and reported at the end of June, 1867.

“As to the main question, they declared they were satisfied that both the quantity and quality of the water supplied from the Thames were so far satisfactory that there was no ground for disturbing the arrangements made under the Act of 1852, and that any attempt to do so would only end in entailing a waste of capital and an unnecessary charge upon the owners and occupiers of property in the Metropolis.

“The water of the Lee they found not only wholesome, but comparing favourably with that supplied to other places. They agreed with the Rivers' Commission that it was liable to serious contamination, but they suggested certain alterations in the remedial measures proposed (see next paragraph), and expressed their opinion that when these were carried out the water supplied by the Companies would be of an unquestionable character.

Par. 129.—“In 1868 an Act (31 and 32 Vic., cap. 154) was passed, to make better provision for the preservation and improvement of the River Lee and its tributaries. It was analogous to the Thames Conservancy Act of 1866, altering the constitution of the managing body, and rendering illegal the admission of sewage or offensive matter into the river, except in the case of certain towns where measures had been adopted for its purification.

Par. 149.—“It admits of no question that the Metropolis ought to be supplied with water that is perfectly wholesome in quality. . . . And if it could be clearly proved that either now, or in a proximate future, wholesome water could not be obtained from the Thames basin, the question of the abandonment of the source would demand prompt attention. . . . We have endeavoured to get the best information possible, from scientific men of the highest reputation, and who have had the best means of making themselves acquainted with the subject, and we have given their evidence its due weight; but we have also been obliged on some points to rely on other considerations in arriving at our decision.

Par. 180.—“But though for these reasons we believe that the organic contamination of the Thames is much less than is commonly imagined, still it would be sufficient to do great mischief, were it not for a most beneficial provision of nature for effecting spontaneously the purification of the streams. . . . The organic compounds dissolved in water appear to be of very

* Report presented to the Right Honourable the President of the Local Government Board, on the Composition and Quality of Daily Samples of Water supplied to London during the year 1881.

* The late Rivers Pollution Commission, some of whose reports touch incidentally on the question of water supply, consisted during the greater part of its existence of two persons only, a well-known agriculturist, and the eminent chemist whose monthly reports to the Registrar-General were, in respect to their mode of statement and inferences, made the subject of unfavourable comment by the Commission on Water Supply.

unstable constitution, and to be very easily decomposed, the great agent in their decomposition being oxygen, and the process being considerably hastened by the motion of the water. . . . This purifying process is not a mere theoretical speculation; we have abundant practical evidence, which we shall hereafter refer to, of its real action on the Thames and other rivers.

Par. 181.—“It does not follow that all organic matter in water is prejudicial; great mistakes have arisen on this point, as it is often given out that the very suspicion of organic contents of any kind in a drinking water should disqualify it for use. But almost all our drinks other than water owe their distinctive qualities to the varieties of their organic contents, and hence it is clear that the presence of organic matter *per se* is not necessarily prejudicial. It is, however, necessary in potable waters which contain organic matter carefully to distinguish between such combinations as are innocent and such as are noxious; and here lies one of the greatest difficulties.

Par. 193.—“Although these analyses of Thames waters (those made for the Commission by Drs. Frankland and Odling jointly) will require repetition and extension before the exact value of all the facts can be determined, yet as they relate to the river at one season, they may be accepted as relatively correct, and they are sufficient to show at least not only the absence of any increase of objectionable matter in the river from Lechlade to Hampton, but that the variations in the quality, which commence at Lechlade, after showing several temporary changes in many parts of the river's course, fall at Hampton in general to a point as low as at Lechlade,* and in one respect, viz. the organic nitrogen, to a point even lower.

Par. 194.—“ . . . And further, we cannot but consider it unphilosophical when, in addition to treating as “impurities” substances perfectly harmless even in much larger quantities, the minute quantities present in a gallon, or any other small measure of water, are multiplied by taking masses of water such as the individual never has to deal with, and given to the public in figures so large as tend to cause misconception and perhaps unnecessary alarm in the minds of those not conversant with all the conditions of the case. It would be as just to speak of the small proportion of carbonic acid present in the atmosphere, equally in populous cities and in the Alps, as an impurity, and to startle those unacquainted with the subject by giving in some large figures the total quantity of that gas present in the atmosphere of London.

“ . . . Few waters are free from organic matter, but all organic matter is not objectionable in small quantities.

“It is contended, and no doubt with truth, knowing beforehand the probabilities of the case, that although the soft waters of the mountainous districts of England and Wales contain as much organic matter as the Thames water, there is an essential difference in its quality. Still the evidence is by no means conclusive even on this point. Whilst on the one hand there is clearly far less objectionable matter introduced into the former, on the other hand the remarkable power of oxidation possessed by running water, admitted more or less by all chemists, so destroys and removes organic matter that the water regains in great measure its original purity, either unassisted or else further aided by filtration.

Par. 214.—“The evidence we have collected on this subject (that of the organic impurities) presents great diversities of opinion; but there is one result which, we think, is clearly deducible from the facts before us, namely, that in the present state of chemical science, analysis fails to discover, in properly filtered Thames water, anything positively deleterious to health. Whatever may be the difference of opinion with respect to the time required for the removal of all the objectionable

organic matter, all the chemists agree that in Thames water, taken from the present source and properly filtered, all such matter has disappeared, and that the resulting compounds, such as nitrates, &c., remaining therein are innocuous and harmless.

“Having carefully considered all the information we have been able to collect, we see no evidence to lead us to believe that the water now supplied by the Companies is not generally good and wholesome.

Par. 217.—“We are of opinion that, when efficient measures (referring to the Acts of 1866 for the Thames and of 1868 for the Lee) are adopted for excluding the sewage and other pollutions from the Thames and the Lee, and their tributaries, and for ensuring perfect filtration, water taken from the present sources will be perfectly wholesome and of suitable quality for the supply of the Metropolis.

Par. 260.—“We are of opinion:—That there is no evidence to lead us to believe that the water now supplied by the companies is not generally good and wholesome.”

To these extracts from the Commission's Report we will add only a few words, in yet further deprecation of the alarmist statements, chemical and hygienic, so frequently made with regard to London water. And we would first call attention to what is indeed a matter of common knowledge, namely, that the natural conditions of river life, irrespective of drainage from houses and cultivated land, are on the one hand constantly furnishing organic matter to the river water, and on the other hand as constantly destroying this organic matter, so as to keep down any excess. It thus happens that a small proportion of organic matter, appreciably greater in winter than in summer, occurs as a normal constituent of most river waters; a constituent, however, which, as pointed out by the Water Supply Commission, there is not any reason to regard as objectionable. And indeed it has not, we believe, been suggested that Thames water, at Lechlade for instance, would be unsuitable for town supply by reason of its containing a small proportion of organic matter; any more than that Thirlmere Lake and Loch Katrine waters are unsuitable for town supply by reason of their containing a similar small proportion of organic matter. But at the Companies' intake at Hampton, the organic matter in the water of the river is, in respect to quantity, admittedly not in excess of that in the water at Lechlade; while, as regards the nature or quality of the organic matter at the two points of the river, it is unquestionable, as affirmed by the Water Supply Commission, that mere chemistry, however refined, has not been able to distinguish a difference, or even to establish the presumption of a difference. Of course, in a strictly chemical sense, the small proportion of organic matter present in Thames water at Lechlade as at Hampton, is an “impurity”; but only in the same sense that the vivifying oxygen by which Thames water is so abundantly aerated is also an impurity. And, in common with the Water Supply Commission, we take it as manifest that this applicability of the word “impurity” in a strictly limited and esoteric sense does not justify its use in a popular sense; and we maintain further, that the natural increase according to season, in the proportion of a minute and objectionable constituent of river water as of lake water does not justify the river water being stigmatised from time to time as largely “polluted.” But despite of all protests, this unfounded use of the words “impurity” and “pollution” will doubtless be continued for some time “to startle those unacquainted with the subject.” Sooner or later, however, we venture to think that these scarecrow terms will follow in the

* Lechlade, where the main stream of the Thames is formed, is situated 126 miles above Hampton.

* It is easy enough, by selecting the period, criterion, standard, and instances, to make a comparison that will exhibit any particular waters in a position of bad pre-eminence. Thus in the month of August, the organic matter, or so-called “pollution,” alike of the Birmingham Corporation's water and of the Glasgow Corporation's water, was, according to the figures given in the Registrar General's Report, twice as great as that of the New River Company's water although, indeed, attention was not called to the circumstance.

wake of their fellow expression, "previous sewage contamination," which, no longer serving to point a moral in the right direction, has been judiciously though tardily abandoned.

But irrespective of chemistry, is there any evidence to show that the Companies' water, supplied as it is to a population of several millions of people, is injurious to their health, or that it constitutes a means of spreading typhoid or other diseases. The answer to this question, must, it would seem, be sought for in statistics—not indeed in selected statistics of short periods, as of a week or fortnight's duration, but in statistics made out on a sufficiently extensive scale to exclude those erroneous inferences to which limited statistics are so especially liable. The answer afforded by statistics of this character

has been made the subject of detailed investigation by one of ourselves (Dr. MEYMOTT TIDY), and we reproduce, together with his remarks thereon, two Tables which he published in the *Journal of the Chemical Society* for May, 1880. So far as we know their accuracy has never been challenged:—

"Let us compare the statistics of death in towns supplied by river water, with those of towns supplied by deep well and spring waters. I have devoted much time to this question, and in the endeavour to obtain a large body of facts upon which to draw some conclusions, I have taken the statistics for 10 years of 18 towns supplied by well and spring water, to compare with the same 10 years' statistics of 18 towns supplied by river water. My results are stated in the following Table:—

TABLE showing the average death-rate, and the number of deaths, &c., from various diseases during 10 years in 18 towns supplied by deep well or spring water, and in 18 towns (omitting London) supplied by river water.

	Estimated Population.	Average Death-rate.	Diphtheria.	Fever.	Diarrhoea.	Cholera.	Disease of Kidneys.
18 towns supplied by wells ..	889,340	22·72	1508	7549	9982	632	2851
18 towns supplied by rivers ..	911,742	22·66	1329	8321	7900	1046	2811

TABLE deduced from the above, showing the deaths per year from the several causes per 1000 of the estimated population.

	Diphtheria.	Fever.	Diarrhoea.	Cholera.	Disease of Kidneys.
18 towns supplied by wells.. ..	0·1695	0·8488	1·1223	0·0710	0·3205
18 towns supplied by rivers	0·1457	0·9126	0·8664	0·1147	0·3083

TABLES SHOWING THE AVERAGE RATES OF MORTALITY PER THOUSAND OF THE POPULATION FOR THE TEN YEARS 1868 TO 1877, IN THE SEVERAL DISTRICTS IN LONDON AND THE NEIGHBOURHOOD.

Compiled by Mr. BALDWIN LATHAM, C.E., F.G.S., &c.

Name of District.	Source of Water Supply.	Birth-rate.	Death-rate.	Phthisis death-rate.	Fever death-rate.	Enteric Fever death-rate.	Scarlatina death-rate.	Diarrhoea death-rate.	Cholera death-rate.	Diphtheria death-rate.	Dysentery death-rate.	Estimated Population, 1877.
Lambeth ..	Lambeth, and Southwark and Vauxhall Water Companies	38·55	23·30	2·46	0·61	0·32	0·92	1·00	0·05	0·13	0·02	229,190
Wandsworth ..		36·02	19·85	2·04	0·41	0·20	0·83	0·93	0·05	0·12	0·02	169,890
Totals		74·57	43·15	4·50	1·02	0·52	1·75	1·93	0·10	0·25	0·04	
Average		37·28	21·57	2·25	0·51	0·26	0·87	0·96	0·05	0·12	0·02	
Greenwich ..	Kent Water Company ..	37·65	22·76	2·53	0·53	0·27	0·81	1·05	0·04	0·10	0·09	110,920
Woolwich ..	Kent Water Company ..	37·38	20·21	2·63	0·54	0·27	0·98	0·93	0·06	0·19	0·03	74,000
Totals		75·03	42·97	5·16	1·07	0·54	1·79	1·98	0·10	0·29	0·12	
Average		37·51	21·48	2·58	0·53	0·27	0·89	0·99	0·05	0·14	0·06	
Camberwell ..	Lambeth, Southwark, and Vauxhall, and Kent Companies (Kent Company in part of Peckham)	36·20	20·73	2·18	0·41	0·21	0·77	0·97	0·07	0·09	0·03	150,650
Lewisham ..		31·42	15·82	1·60	0·27	0·19	0·67	0·67	0·02	0·14	0·01	64,000
Totals		67·62	36·55	3·78	0·68	0·40	1·44	1·64	0·09	0·23	0·04	
Average		33·81	18·27	1·89	0·34	0·20	0·72	0·82	0·04	0·11	0·02	
London		35·70	23·13	2·65	0·49	0·26	0·86	1·03	0·05	0·11	0·02	3,533,484

"These details, which, let me add, have been tested in a variety of ways, are remarkable. The 18 well towns had an estimated population of 889,000, and the 18 river towns a population of 911,000. In population, therefore, they were closely comparable. The well towns had an average death-rate of 22.72 per 1000, and the river towns a death-rate of 22.66, a difference of 0.06 in favour of rivers as a water supply over wells. Analysing the details, wells have the advantage in deaths from fever in the proportion of 8.483 per 1000 against 9.126 per 1000 in the case of rivers. Similarly in the case of cholera, wells stand before rivers in the proportion of 0.710 deaths per 1000 in the well towns against 1.147 in river towns. On the other hand, river towns show to advantage in diphtheria, 1.457 deaths per 1000 being registered in river towns against 1.695 in well towns. The difference is most remarkable in the case of diarrhoea, for in river towns 8.644 deaths per 1000 are recorded, whilst in well towns we have an average of 11.223 deaths per 1000. It is worthy of note, in passing, that deaths from diseases of the kidneys are as nearly as possible alike in both.

"At any rate these statistics, as they are on a very extensive scale, prove tolerably conclusively, it appears to me, that there is no evidence to show any manifest difference in the matter of health between towns supplied by wells and those by rivers.

"Again, we have in London certain places supplied with river water, a second series supplied with deep chalk water, and a third series supplied with a mixture of river and chalk water. It is worth our while to compare the death statistics of these districts one with another. Again I am indebted to Mr. Baldwin Latham for the Table (see p. 182), the details of which I have myself verified. (1.) Lambeth and Wandsworth have been selected as districts supplied with river water only, by the Lambeth and the Southwark and Vauxhall Water Companies; (2.) Greenwich and Woolwich, as fairly comparable districts, supplied entirely with chalk water by the Kent Water Company; and (3.) Camberwell and Lewisham have been taken as districts supplied partly by a company deriving their supply from a river (both the Lambeth and the Southwark and Vauxhall in the case of Camberwell, and the Lambeth only in the case of Lewisham) and partly with chalk water. The average of ten years has been taken, and the results show that the death-rate from all causes in the river districts and the death-rate in the well districts are practically identical, whilst the death-rate of those districts receiving a mixed supply is manifestly less than either. But what is more remarkable still is, that the death-rate from enteric fever, from scarlatina, from diarrhoea, from diphtheria, and from dysentery is in each case slightly lower in the districts supplied with river water than in the districts supplied with well water, whilst so far as cholera is concerned the returns in both are identical."

Taking into consideration the results of our extensive series of chemical analyses of the water supplied to London, and the fact that the death-rates of well-water towns and river-water towns are practically alike, and of the further fact that in the Metropolis there is very little to choose, judged by mortality, between districts supplied with deep-well water and districts supplied with river water, any slight difference being in favour of the districts supplied with river water, we are of opinion that the filtered water of the Thames and Lee is unimpeachable in respect of its wholesomeness and suitability for town supply.

We have the honour to remain, Sir,
Your obedient Servants,
W. CROOKES,
W. ODLING,
C. MEYMOTT TIDY.

Reactions of Urine after Use of Balsam of Copaiba.
—M. Thoms.—In searching for uroxanthine or indican in urine, the similar reaction obtained after the use of copaiba should be taken into consideration.—*Journ. de Pharmacie*.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, April 20, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—
W. L. Goodwin, R. N. Wolfenden.

Dr. RAMSAY then read a paper "*On the Atomic Volume of Iodine*." The author has determined the atomic volume of boiling iodine. The experiment was somewhat difficult owing to the opacity of iodine vapour; the results of four experiments were 34.07, 39.27, 35.62, 37.79, the mean being 36.69, with a probable error of 0.7749. The numbers deduced by Kopp and Thorpe from the molecular volumes of compounds containing iodine were respectively 37.2 and 36. The author concludes that it may therefore be accepted as proved that elements in compounds occupy the same volume as elements in the free state. Thus, the following elements give values in the free and combined states respectively:—Bromine, 27.13, 28.1; iodine, 36.69, 36.6; sulphur, 21.6, 22.6; phosphorus, 20.9, 20.7. Nitric peroxide also gives values—free, 32.0, and combined, 31.5.

Dr. RAMSAY then read a second communication, "*On Molecular Volumes*." The author compares the two well-known statements of Kopp—1. In homologous compounds for each increase of CH_2 the molecular volume increases by a mean value of 22. 2. Carbon (C) can replace hydrogen (H_2) without change of molecular volume, with the antagonistic theory of Schröder, which may be shortly summed up in the two statements: All elements occupy the same bulk, or a multiple of that bulk, named a "stere"; and the stere is a variable quantity. Both these theories involve an unwarrantable assumption, viz., that the atomic volumes of liquids are comparable at their boiling-points under equal tensions. The author then proceeds to give experiments designed to test the validity of this assumption, and for convenience sake confines himself to the alterations of the group CH_2 . In the first table the values for this group CH_2 are given as obtained from bodies compared at the boiling-point under a pressure of 760 m.m.; the values in 12 cases vary from 18.03 to 23.23. Great care was taken to ensure the purity of the substances employed—water, methyl alcohol, ethyl alcohol, ethyl ether, isopropyl alcohol, isobutyl alcohol, methyl acetate, ethyl acetate, isopropyl acetate, isobutyl acetate, amyl acetate—and to ensure the accuracy of the results by check experiments. It is obvious from the numbers obtained that the value of CH_2 is not constant at the boiling-point under a pressure of 760 m.m. The next step was to ascertain whether a better agreement is obtainable at pressures lower or higher than the normal. Tables are then given which indicate the volumes at pressures (a) below the normal, (b) at pressures above the normal, but below 10 atmospheres, (c) at pressures up to the critical point. A description of the apparatus with which the results were obtained is also given. A study of these numbers shows (1) that the value of the group CH_2 becomes less constant the higher the pressure. Thus, at a pressure of 20 millimetres, it varies from 17 to 21; at 760 m.m., from 18.03 to 23.23; at 5000 m.m., from 20.26 to 26.88; at 30 atmospheres from 26.1 to 54.3. (2.) That as a rule the value of CH_2 increases regularly in amount with the increase of tension. (3.) That its value, as deduced from methyl alcohol and water, is exceptional. It is clear, therefore, that if CH_2 has a constant value at any temperature, that temperature must be very low. The author then speculates as to the condition of matter, which renders the idea of an invariable molecular volume tenable. The expression molecular volume means not merely the space occupied by the molecules themselves, but this space plus the space occupied by the interstices between the molecules, and the variation of the volume of the group CH_2 .

is probably due to the fact that this latter space is not constant. The author then considers the case of solids crystallising in similar forms, and suggests that in such cases the interstitial spaces are probably identical, and the observed molecular volumes would give the volumes of the molecules plus a constant, expressing the value of the interstitial space; but until this constant is determined no definite conclusion can be drawn. The relative probabilities of the theories of Kopp and Schröder are then indicated, and the author states that Schröder's hypothesis is untenable, and that by his assumption of the variability, within limits of 10 per cent, of the "stere" and the power of doubling, trebling, and quadrupling, if necessary, the number of steres assigned to any element, he gives to his system an appearance of coincidence with experimental results which it does not really possess.

Dr. JAPP then read a paper "*On the Action of Acetone on Phenanthraquinone, both alone and in the Presence of Ammonia*," by F. R. JAPP and F. W. STREATFIELD. In a previous paper the authors studied the action of phenanthraquinone in the presence of ammonia on aldehyde, and in the present paper the action of these two bodies on the ketone-acetone, is investigated. 50 grms. of powdered phenanthraquinone were mixed in a stout flask with 60 grms. of acetone, and 40 c.c. of strong aqueous ammonia added. The flask was corked, the reaction commenced, and the temperature rose, and finally a white granular crystalline powder separated out from the dark-coloured supernatant liquid. The substance was purified from some unaltered quinone; it melted with decomposition at about 130°; analysis indicated the formula $C_{17}H_{15}NO_2$; it is named by the authors acetonequinimide of phenanthrene. This substance dissolves readily in cold concentrated hydrochloric acid, yielding a pale yellow solution, which becomes green, and on, standing, deposits an indigo-blue substance. When much water is added, colourless needles were gradually formed, which, after crystallisation from ether, were obtained in thin colourless blades, melting at 89.5° to 90°; analysis indicated the formula $C_{17}H_{14}O_3$; it is named acetonequin of phenanthrene. If oxalic acid be used instead of hydrochloric acid the same substance, $C_{17}H_{14}O_3$, is formed, but there is no indigo-blue deposit. By treating this compound, $C_{17}H_{14}O_3$, with ammonia the original substance, $C_{17}H_{15}NO_2$, is reformed. By heating, $C_{17}H_{14}O_3$ is decomposed into phenanthraquinone and acetone, and again $C_{17}H_{14}O_3$ can be synthesised by heating these two bodies in sealed tubes to 200°. The authors conclude the paper with some considerations on the constitution of phenanthraquinone.

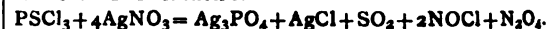
The following papers, in the absence of the authors, were read by the SECRETARY:—

"*A Study of some of the Earth Metals contained in Samarskite*," by H. E. ROSCOE. The probable existence of a new metal in this mineral was announced by Delafontaine in 1878, and confirmed by him shortly afterwards, when it was named Philippium. The most characteristic salt is the soluble formiate, which is deposited in well-defined rhombic crystals, and indeed is the only means (except its constant atomic weight) of distinguishing this metal from terbium or yttrium. Terbium formiate is a white powder, whilst yttrium formiate is much more soluble, and usually deliquescent. The author has investigated the subject, starting with 1500 grms. of samarskite; he obtained about 60 grms. of oxides, containing philippium, terbium, yttrium, and traces of erbium. These oxides were converted into formiates, and a most elaborate series of fractional precipitations, &c., carried out in order to obtain the pure philippium salt, but the author entirely failed in procuring an oxide having an unalterable atomic weight of 122. The numbers varied between the atomic weights of terbium and yttria. The following conclusive experiment was then tried:—3 grms. of terbium having an atomic weight of 147.9 and 3 grms. of crude yttria with atomic weight 101.4, were respectively converted into formiates. Of each of these two formiates, two-thirds were brought into solution separately, whilst the other

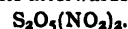
third of the terbium formiate was mixed with the remaining third of yttrium formiate, and the mixture dissolved. Each of the three solutions was then mixed with an equal bulk of alcohol and allowed to stand for the same length of time. The two solutions, containing respectively terbium and yttria, gave crystals presenting the ordinary appearances of formiates of terbium and yttria, but the third solution, containing the mixed formiates, deposited rhombic prisms, which could not be distinguished from the supposed formiate of philippium. These results prove that the mixed formiates of terbium and yttrium are capable of crystallising together in a form ascribed to philippium.

"*On the Spectrum of Terbium*," by H. E. ROSCOE and A. SCHUSTER. The authors have mapped carefully the spectrum of this element. A Rutherford grating was used. The specimen of oxide, which ought to contain philippium in large quantities, should that element exist, showed, with the exception of one line, which could not be identified, only lines belonging to yttrium or terbium.

"*On the Action of Thiophosphoryl Chloride upon Silver Nitrate*," by T. E. THORPE and S. DYSON. The authors hoped by the above reaction to form a mixed anhydride, one on the type of nitric anhydride, but containing some of the oxygen replaced by sulphur. No such body was formed. The reaction is—



The condensed products afterwards unite to form—



"*Note on the Action of the Oxychlorides of Sulphur on Silver Nitrate*," by T. E. THORPE.

"*On the Behaviour of Zinc, Magnesium, and Iron as Reducing Agents with Acidulated Solutions of Ferric Salts*," by T. E. THORPE. The author has carefully investigated the conditions which accelerate or retard the reducing action of the above metals. The maximum reducing action possible with a given weight of zinc is obtained by concentrating the ferric sulphate solution and diminishing the amount of free acid; increase of temperature augments the reducing action. Magnesium is similarly affected by varying conditions, but is inferior in reducing power to zinc. In the case of iron, increase of temperature apparently decreases the reducing powder.

"*Experiments on the Action of Potassium Amalgam, Sulphuretted Hydrogen, and Potassic Hydrate, respectively, on Tetra- and Penta-thionates of Potassium*," by V. LEWIS. Potassium amalgam acts upon tetrathionate, forming hyposulphite; if the amalgam be in excess some sulphide is also formed; similar products are formed with pentathionate. Sulphuretted hydrogen with tetrathionate forms hyposulphite, and precipitates sulphur. Potassium hydrate acts upon pentathionate, forming hyposulphite, sulphite, and sulphur; with tetrathionate, sulphite and hyposulphite are formed. Most of these reactions have been investigated quantitatively.

The Society then adjourned to May 4, when Prof. J. Dewar, F.R.S., will deliver a lecture "On Recent Developments of the Theory of Dissociation."

Experimental Researches on the Thermic Conductivity of Minerals and Rocks.—J. Thoulet.—Among the considerations needful for ascertaining the mode of formation of minerals and rocks, one of the most important data is that of the temperature to which they may be brought by convection. The author names "thermic resistance" the time required for a constant quantity of heat which in his experiments is 34°, proceeding from a source at 100° in contact with the lower surface of a rock, may reach the upper surface, at a distance of 0.010 metre. This thermic resistance is a function of the coefficient of conductivity, as defined by Fourier and Lamé. The novelty of the author's method is the substitution of a precise evaluation of times for the determination of temperatures.—*Comptes Rendus*.

NOTICES OF BOOKS.

On the Present Condition of the Royal Military Academy, Woolwich. By an Ex-Professor (who served for twenty-six years.) London: Ballantyne, Hanson, and Co.

THE author of this pamphlet, Mr. C. L. Bloxam, has, as a teacher of chemistry and physics, few equals and no superior in the United Kingdom. For a quarter of a century he fulfilled his duties at the Royal Military Academy ably and faithfully, but he has been ultimately compelled to resign because the authorities, who ought to have supported him, connived at disorder and tolerated a laxity of conduct on the part of the students—we beg pardon, "Gentlemen Cadets"—which to our non-official mind seems eminently out of keeping in a Military College, and which would not be tolerated for a single week in similar establishments in Germany, or even in France. During the first fourteen years of Mr. Bloxam's long term of office down to 1870 everything was on a satisfactory footing. "The cadets were paraded and marched into the lecture-room in charge of a lieutenant, who remained throughout the lecture in order to command silence and attention. The Assistant Inspector also attended the lectures, and the Inspector of Studies was a frequent visitor in his official capacity. The Governor would generally give the sanction of his presence at the opening lecture of each term and on two or three subsequent occasions." The result of such arrangements was what might naturally be expected. The cadets saw the lectures regarded by the heads of the Academy as a serious and important matter; they saw the Professors treated with respect, and they shaped their own conduct accordingly. In 1870, however, a so-called "reform" was inaugurated. It was, we believe, about the time when the cats at the Royal Dockyards were placed upon a reduced allowance of meat and milk, so that possibly the motive may have been short-sighted economy. However this may be, "the appointments of Inspector and Assistant Inspector of Studies were abolished, the officer in charge was removed, the Cadets were no longer marched in, and a circular was addressed to the Instructors admonishing them that 'tact and temper' were to replace the officers in charge, and that, in short, military discipline would cease to be applied to the Cadets in hours of study, and the Instructors would be required to do duty as ushers in an ordinary boarding-school." We find it difficult to restrain our "temper" on learning the indignity thus offered, not merely to the person of Mr. Bloxam, but to a professorial chair once occupied by Faraday. For the teachers of a boarding-school, or of a board-school, it may be practicable to combine the twofold, and often heterogeneous, tasks of conveying instruction and maintaining order. But to force the latter task upon men of well-earned eminence, to equip Professor Bloxam in the cocked hat of Bumble, is an outrage to Science. It was on this very ground that we felt indignant at the unworthy treatment offered to Professor A. H. Church at the Cirencester Agricultural College. He and his learned colleagues were expected to reside on the premises that they might take a part in the enforcement of discipline. It appears that the clerical Principal of Cirencester and the Military Governor of Woolwich agree in the degrading estimate they put upon science and upon scientific men. It is utterly impossible for any Professor to concentrate his attention on the performance of experiments which if neglected may prove dangerous, or to engage in complicated calculations if he has all the time to be on the watch to detect breaches of discipline; if he is "interrupted by a shout of laughter caused by the circulation of an obscene jest;" or has to "break off in the middle of a chain of reasoning in order to discover and place in arrest the originator of some disturbance."

It is further remarked that whilst the first Governor under the "new system" did occasionally visit the Chemical Lecture-room and Laboratory, "His successor

attended one lecture only, and on no other occasion visited the chemical class-rooms whilst the Cadets were there. The present Governor has never done so yet."

The following circumstance is exceedingly significant. According to the arrangements made in 1870, the Academy was to be independently inspected by a Board of Visitors, nominated by the Secretary of State for War, and reporting to him yearly. For two years in succession Mr. Bloxam had the opportunity of appearing before this Board. On the second occasion he "called the attention of the Board to the inexpediency of allowing Cadets to obtain leave from the Governor to absent themselves from the class for cricket or football matches without first applying for the sanction of the Professor." This very reasonable remonstrance was attended to, and has been acted on ever since, with good results as far as discipline is concerned. But the writer adds—"I have never since had the opportunity given me of meeting the Board of Visitors." What inference can we draw but that the Heads of the Academy do not wish to enforce good order, and would rather undermine than uphold the authority of the instructors?

As further instances of the manner in which Mr. Bloxam has been treated we select the following:—He had to make application for the lobby of the lecture-room to be painted of a dark colour in order to obliterate the "most offensively obscene drawings and writings" with which they had been decorated by the Cadets and to prevent their reproduction. In reply to his request for this lustration, and for a general cleaning of the walls, &c., of the laboratory and lecture-room, he received a verbal message that there were *no funds available!* He was, however, graciously permitted to have the work done at his own expense. At the time of this "lack of funds" considerable expenditure was being incurred in completing a luxurious official residence for the Governor. He applied also for an iron rail to be fixed in front of the lecture-table "to prevent the damage to apparatus and the abstraction of specimens, due to the disorderly conduct of the Cadets." This request was refused, and Mr. Bloxam had to have the rail put up at his own cost!

On one occasion some of the Cadets in passing from the laboratory through the lecture-room turned on more than a dozen gas-taps. The premises were filled with an explosive mixture, and had anyone entered with a light the east wing of the Academy would have been a wreck. No investigation was held, and no punishment was inflicted for this offence, though Mr. Bloxam made it the subject of a prompt and urgent report.

As one of the many evil results of the new system, the Professor was obliged to discontinue the *viva voce* examination with which he had heretofore supplemented each lecture, since the cadets only took it as an opportunity for "chaff."

In 1880 he addressed to the Governor a very temperate letter, pointing out the unsatisfactory position of the class arrangements, and making certain very serious allegations. If his statements had been doubted they should have been at least enquired into. This letter was not even acknowledged!

Ultimately Prof. Bloxam determined to resign, and though requested to remain for one year longer from February 8th of the present year, he carried out his intention. We think all persons capable of reasoning, if they read his pamphlet, will agree with us that the treatment he has received for the last ten years has been simply disgraceful. What justification or palliation of their conduct the introducers and upholders of the new "system" (? un-system), and the recent Governors of the Academy have to offer is to us a mystery. If they wished to inculcate insubordination and turbulence in the future holders of Her Majesty's Commission; if they sought to render it impossible for officers of the Royal Engineers and the Artillery to acquire that knowledge of chemistry and physics which are felt to be needed in modern warfare they could but have acted as they have done. But if they considered lectures and laboratory work a farce,

or if they doubted Professor Bloxam's competence, why did they ask him to continue his services? Their conduct seems a sad blend of official insolence and neglect of obvious duty. We hope that public opinion will speak on this subject in tones which cannot be mistaken.

As regards the economy achieved by suppressing the offices of the Inspector of Studies and his Assistant, it is interesting to note that the salary of the Governor, which in 1878 was £1500, was last year raised to £2000, whilst that of the Secretary, which was £400 in 1878, was advanced at the same time to £700!

CORRESPONDENCE.

ESTIMATION OF NITRIC AND NITROUS NITROGEN IN THE STATE OF AMMONIA.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xlv., p. 159, there is a note by Mr. Hugo Tamm, upon the estimation of nitric and nitrous nitrogen by conversion into ammonia during an ordinary combustion analysis, the author slightly altering the well-known soda-lime method by addition of acetate of soda.

Having worked much and long upon this question of estimation of nitro-nitrogen by combustion, I am astonished at the confident expressions used by Mr. Tamm. Having met with many failures, and numerous, though almost complete, results before finding a process which could be relied upon, to be yet told that an agent—acetate of soda, "dry" or not, or marsh-gas—could be employed successfully whilst I had tried and rejected them years ago as unreliable, is a great surprise. Mr. Tamm also tells us he would certainly have succeeded in applying the reactions of sulphide of sodium, and almost dry proto-sulphate of iron, &c., if he had not superseded them by the marsh-gas and soda-lime method. This is also great news, as proto-sulphate of iron was tried and found wanting eight or ten years ago by several chemists.

Permit me to say (as part of the results of over 800 combustions on this subject), for the information of Mr. Tamm and your readers in general, that, roughly, the best partial results can be obtained with crystallised sulphide of sodium favourably mixed with soda-lime; 90 to 97 per cent of the nitrogen can be estimated, but still unreliably. The next generally best reagent is proto-sulphate, or proto-chloride of iron, crystallised, and duly mixed with soda-lime, but in all cases "dry," or "almost dry," reagents do not succeed, and, even in the published successful method, the presence of H_2O is essential to success, and it is for that reason that ordinary crystallised hyposulphite of soda is used.

With any organic matter, whether acetic acid as an acetate, or other acid, neutral, or basic body, partial results only can be obtained depending upon the degree of intimate admixture of the reagent with the substance analysed, but still not reliable complete results. I am sorry to say this in the face of Mr. Tamm's assertions, but one cannot resist facts repeatedly ascertained. Perhaps Mr. Tamm's method has been undescribed, but we can only take it as given in your pages; and, anxious to see whether, after all, simple acetate of soda and soda-lime would answer, I tried Mr. Tamm's method exactly as given. I used about $\frac{1}{2}$ gm. of pure nitrate of soda for one combustion, and obtained as a result 9.21 per cent of the nitrogen estimated against 16.47 per cent the nitrate contained. I also made a mixture of one quarter pure sulphate of ammonia, one quarter pure nitrate of soda, and a half ordinary superphosphate; beat the whole into a paste, as is usual for a superphosphate analysis, took a portion of rather under a gramme for analysis, cut it up

fine with some kaolin, and burnt it as Tamm directs. The mixture contained 5.30 per cent nitrogen as ready-formed ammonia, and 4.11 per cent of nitrogen as nitrate; together a total of 9.41 per cent. The analysis gave a result of 7.53 per cent only, showing a deficit of 2 per cent!

I hope that Mr. Tamm (whom I have not the pleasure to know personally) will pardon my remarks, which are *bona fide*, but having worked on the subject, having published several notes thereupon in your valuable columns, I am naturally interested in the question, and if Mr. Tamm will refer to the *Journal of the Chemical Society* for March, 1881, he will find there published a process—with results—for the estimation of nitro-nitrogen by combustion, which answers completely with pure substances, and can be applied to a pasty admixture of superphosphate. There is a special reason for dwelling upon this point, as it was difficult to get over, and even do something more. If Mr. Tamm wishes, I will forward him a copy of the reprint, with also some results not therein given; and finally I will mention that this process has been tried by chemists in England and on the Continent, and found satisfactory.—I am, &c.,

JOHN RUFFLE.

April 18, 1882.

COMBINATION OF OXYGEN AND HYDROGEN UNDER THE INFLUENCE OF THE SILENT DISCHARGE.

To the Editor of the Chemical News.

SIR,—Two papers appear in the *Comptes Rendus* of the French Academy, dated November 28 and December 5, 1881, respectively, by MM. Dehérain and Maquenne. The first paper describes the decomposition of water in partially exhausted induction tubes under the influence of the electric effluve without any visible spark. The second paper describes the combination of oxygen and hydrogen gases under similar conditions, sometimes attended with explosion.

Now, in a paper sent by me to the Royal Society on October 8, 1881, and read before that Society last November, but which for some reason has not been published, the following paragraph occurred:—

"In the course of my work with the induced current, I incidentally discovered that a mixture of $O + H_2$ may be exploded by a current of a certain intensity without the agency of the spark. Probably this is due to the production of ozone under these conditions."

I therefore beg to take this opportunity of claiming priority in the observation of the explosion of moist oxygen and hydrogen gases under the influence of the effluve without visible sparks.—I am, &c.,

G. STILLINGFLEET JOHNSON.

Chemical Laboratory, King's College, W.C.,
April 21, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 15, April 10, 1882.

The Evaluation of Thermic Conductivity by a Measurement of Times during the Variable State.—H. Lagarde.—It is possible with two plates of the same substance, differing slightly in thickness, to find, by four determinations of time rapidly executed, either the thermic resistance or the coefficient of conductivity, which form an important characteristic constant for various substances.

Electrolysis.—D. Tommasi.—The author demonstrates that when a galvanic current traverses several electrolytes, in order that there may be decomposition, the quantity of calories produced by the battery should be equal to the sum of the calories absorbed by each electrolyte augmented by the calories necessary for overcoming the total resistance of the electrolytes. By calories produced by the battery he means those which are transmissible to the circuit. He has also collected facts concerning the ratio existing between the calories produced by the battery and the calories absorbed by several voltmeters containing water, saline solutions, or melted salts.

Researches on the Solubility of the Aluminates of Lime in Water: Influence of this Solubility upon the Final Setting of Hydraulic Materials.—E. Landrin. The author shows that the calcium aluminates are soluble in water, and are hurtful in hydraulic cements. Hence the puzzolani, which contain no soluble aluminates, give excellent results. Ferric oxide plays a totally negative part in the setting of hydraulic cements.

Relation between Isomorphism, Atomic Weights, and Comparative Toxicity in Metallic Salts.—J. Blake.—The author criticises the conclusions drawn by M. Richet from his experiments on fishes placed in solutions of metallic salts, on the ground that poisonous substances, if brought in contact with mucous membranes, act differently from what they do when introduced into the blood. It must also be remembered that different salts have very different coefficients of diffusion. If two salts are dissolved in water in the same proportion, still if they come in contact with a mucous membrane like that which covers the gills, they enter the blood in very different proportions. The speed with which the salts, after having entered into the blood, are eliminated by the kidneys is not the same, and the local action of the salts upon the tissue of the gills may also vitiate any conclusion as to the relative toxicity of the metals drawn from the experiments of M. Richet.

Certain Physical Properties of Camphor Bichloride.—MM. P. Cazeneuve and Didelot.—This compound is insoluble in water, to which it imparts, however, its peculiar odour. It is slightly soluble in cold alcohol, but dissolves to any extent at the boiling-point. It is very soluble in chloroform and in carbon bisulphide, and extremely soluble in ether, liquefying even in the vapour of ether. From this solution it does not easily crystallise, the ether being retained energetically. Camphor bichloride is insoluble in acetic acid, in which camphor dissolves. It is soluble in aldehyd, forming a liquid more dense than water. The specific gravity of camphor bichloride is 4.2; its melting-point is 96°.

Peptones and Alkaloids.—C. Tanret.—This paper is a reply to that of M. J. Béchamp in the last number of the *Comptes Rendus*.

Moniteur Scientifique, Queneville.
April, 1882.

Azo-Colouring Matters.—O. Wallach.—An account of azo-benzin-resorcin and azo-toluen-resorcin, taken from the *Berlin Berichte*.

Compounds of the Indigotic Group.—A. Baeyer.—A description of isatogenic acid, indoxylic ether and acid, ethyl-indoxylic acid, nitroso-ethyl-indoxylic acid, indoxyle, ethyl-indoxyle, indoxyl-sulphuric acid, and disatogen, taken from the *Berlin Berichte*.

Syntheses by means of Phenyl-acetylene.—MM. Baeyer and Landsberg.

A New Base Homologous with Quinoline.—MM. Dœbner and Miller.—These two memoirs are also taken from the *Berlin Berichte*.

Quinine and Quinidine.—Z. H. Skraup.—The author treats of the oxidation of quinine, of quinic acid and its salts, of the acetylation and oxidation of quinic acid, of

its behaviour with hydrochloric acid with the formation of xantho-quinic acid, and the action of heat upon the latter.

Preparation of Colouring-Matters by the Action of Aromatic Nitro-Derivatives upon Phenols and Polyatomic Alcohols in Presence of Dehydrating Agents.—H. Brunner.—From the *Berlin Berichte*.

Apparatus for the Distillation of Mercury in a Vacuum.—A. W. Wright.—This paper, taken from the *American Journal of Science*, cannot be intelligibly reproduced without the accompanying illustration.

The Latest Improvements in the Manufacture of Artificial Indigo.—The preparation of indigo is still too costly, and its use in printing is attended with such inconveniences that the attempts at its production have been for the present discontinued in the two great establishments which had entered upon the undertaking. Among recent improvements have been the replacement of the oil of bitter almonds and acetic anhydride by benzyl bromide or chloride and anhydrous sodium acetate. Cinnamic acid cannot be quantitatively transformed into ortho-nitro-cinnamic acid, which alone is capable of yielding indigo. A quantity of the para-acid is formed at the same time. Indoine is a new compound obtained by M. Baeyer from ortho-nitro-phenyl-propionic acid. It presents certain analogies with indigo, but is yet distinct.

Anniversary Banquet to M. Chevreul.—On March 5th, a banquet was given by the French National Society of Agriculture to its President, M. Chevreul, in commemoration of the 50th anniversary of his election.

Journal de Pharmacie et de Chimie.
March, 1882.

Chemical Studies on the Skeleton of Vegetables (2nd Part).—MM. E. Fremy and Urbain.—From the *Comptes Rendus*.

Decomposition of Racemic Acid.—E. Jungfleisch.—Already noticed.

Cinchona Tree yielding Cinchonamine.—G. Planchon.—A pharmacological paper.

Study on Essence of Savory.—A. Haller.—Already noticed.

Journal für Praktische Chemie.
No. 3, 1882.

Further Contributions to the Chemistry of Bile.—G. Hüfner.—The author raises the question, What is the respective proportion of taurocholic and glycocholic acids in ox-gall in such cases where the gall at once crystallises on the addition of ether and hydrochloric acid, and in such where this experiment fails? It appears that the crystallisation is most complete and rapid where glycocholic acid largely predominates.

An Air Thermometer.—Designed by O. Pettersson and executed by F. Müller.—This instrument cannot be intelligibly described without the accompanying figure.

Maltose.—Dr. E. Meissl.—The author examines the specific rotatory power, and gives the practical rule that the number of grammes of the active substance in 100 c.c. of solution may be found to ± 0.05 gm. by reading off the degrees of rotation at 17.5° and multiplying by 0.362. The rotatory power becomes less and less as the concentration and the temperature increase, and if seen by the sodium light it may be represented in a solution containing P per cent of anhydrous maltose at the temperature T, by $[\alpha]_D = 140.375 - 0.01837 P - 0.095 T$. The rotatory power of freshly-prepared solutions is lower by 15° to 20° than that of old solutions or such as have been boiled. Maltose resists hydration under the action of diluted acids about five times more strongly than does saccharose. It is most readily converted into dextrose if heated for three

hours with 3 per cent sulphuric acid. Chlorine acts less energetically upon maltose than upon dextrose or saccharose, the acid produced being distinct from gluconic and glycolic acid.

Communications from the Laboratory of Agricultural Chemistry at the University of Königsberg.—H. Ritthausen.—These consist of a memoir on the albumenoid bodies of hemp-seed and of the crystalline albumen of hemp and castor oil seed; on the composition of the crystalline albumen of pumpkin seeds; and on the behaviour of lead chromate in combustions and with oxygen. The author remarks that combustions with lead chromate sometimes give larger quantities of carbon than were expected or calculated. The lead chromate evidently contained a quantity of organic matter, of carbon, or of other bodies volatile at a strong heat and capable of absorption by potassa lye. He therefore recommends that in all cases the lead chromate should be ignited in a current of oxygen before use.

Diiformine, from Glycerin.—P. van Romburgh.—This compound is a neutral colourless liquid of sp. gr. 1.304. It begins to decompose at 175°, the chief product being allyl formiate along with allylic alcohol, formic acid, water, and carbonic acid mixed with a little carbonic oxide.

No. 4, 1882.

The Occurrence of Allantoine and Asparagine in the Young Leaves of Trees.—E. Schulze and J. Barbieri.—The authors have demonstrated the presence of these bodies in the young leaves of the birch, the horse chestnut, and the oriental plane. The occurrence in the vegetable organism of allantoine, a body so closely connected with urea and uric acid, is not without interest.

The Cholesterines.—E. Schulze and J. Barbieri.—Two distinct cholesterines occur in the shoots of lupins. The cholesterines are very widely distributed in plants, and must be regarded as constant ingredients of protoplasm. But their signification for the vital process of plants is still unexplained. They do not belong to those constituents of seeds which are consumed in the process of germination in the absence of light.

Open Letter to Professor Kolbe.—A. Ladenburg.

Explanatory Remarks in Correction of the Errors contained in the above Open Letter.—H. Kolbe.—Matters of personal controversy.

Contribution to a Right Appreciation of Dr. J. L. W. Thudichum's Critique on a Memoir concerning Certain New Cerebral Compounds, by E. Parcus.—E. Drechsel.—The author points out that phrenosine, according to Dr. Thudichum's memoir, forms with cerebrine a mixture containing more carbon than either of its constituents.

Justus Liebig's Annalen der Chemie,
Band 211, Heft 2.

The Chemical Constitution of Organic Bodies with Reference to their Physical Properties (Fourth Part).—J. W. Bruehl.—We can only give the author's principal conclusions:—The refractive power of a body decreases continuously with its gradually increasing combination with oxygen; it becomes smaller the more atoms of oxygen enter into its composition, just as is the case with the combustion-heat. Quite corresponding is the action of the removal of hydrogen or its substitution by oxygen, so that the combustion-heat of the hydrocarbons is greater than that of equal weights of all those bodies formed by the oxidation of hydrocarbons, such as the alcohols, aldehyds, acids, &c. The differences of the constants of neighbouring members of an oxidation-series, decrease both thermically and optically with the increasing molecular weight, the chemical structure being analogous. There appears a complete harmony between the optical and the thermic properties of halogen-substitutes of or-

ganic compounds. The specific refraction-power of these bodies, and their combustion-heat, is the smaller for equal weights the more the hydrogen is replaced by a halogen. The values are smaller in the bromo- than in the chloro-products, and smallest in the iodo-compounds. The optical and the thermic phenomena in the homologous series agree likewise completely. Both the refracting-power and the combustion-heat of equal weights of homologous compounds increase continuously with the increasing proportions of carbon and hydrogen. The differences for the increment CH_2 , in case of both constants, decrease with the increase of molecular weight. Polymerisation decreases both the refracting-power and the combustion-heat of equal weights of bodies, both constants decreasing the more strongly the higher is the molecular weight of the new-formed compound. The double union of carbon atoms which strengthens the power of refraction heightens also their combustion-heat. Both constants of bodies containing such double unions are greater than the constants of the isomeres in which such unions are wanting, and are replaced by a twofold catenation of oxygen with carbon, or by an annular grouping, whether of carbon atoms or of oxygen and carbon atoms. The universal agreement of the thermic and optic behaviour of the liquid organic bodies makes it also probable that the combustion-heat of such bodies, as well as their refracting-power, are heightened by a twofold union of the carbon, though in a less degree than by twofold union of carbon atoms. The so-called double union gives, therefore, not a more intimate but a feebler attraction of the atoms than simple catenation of the same. The assumption of a double union is therefore in direct contradiction with facts. Substances in which manifold unions are assumed are in reality unsaturated, *i.e.*, such in which the power of affinity of the atoms is not called into action to its maximum. As the final results of his investigations the author puts forward the proof of the correlation of the refracting-power and of the combustion-heat that is, the energy of liquid organic compounds. Further, the proof that the so-called double union represents an increased dispersion or disaggregation of their atoms, and consequently a loosening of their connection; hence a double, or indeed a plural, union of atoms does not exist.

Action of the Halogen Compounds of Hydrogen upon Compound Ethers.—Eugen Sapper.—The author considers that Friedel's theory fully explains the formation of esters by the introduction of the halogen hydrides into mixtures of organic acids and alcohols.

Furfurol.—E. Fischer.—The author describes the benzoinoid derivatives of furfurol. Among these he particularly treats of furoine, benz-furoine, furile, benz-furile, together with their derivatives.

MEETINGS FOR THE WEEK.

- MONDAY, May 1st.—Medical, 8.30. (Ann. Oration.)
Royal Institution, 2. (Annual Meeting.)
- TUESDAY, 2nd.—Institute of Civil Engineers, 8.
Pathological, 8.30.
Royal Institution, 3. "History of Customs and Beliefs," by Dr. E. D. Tylor.
- WEDNESDAY, 3rd.—Society of Arts, 8. "The Fire Risks Incidental to Electric Lighting," by Thomas Bolas, F.C.S.
Obstetrical, 8.
- THURSDAY, 4th.—Royal, 4.30.
Royal Institution, 3. "The Metals," by Prof. Dewar.
Chemical, 8. "Recent Developments of the Theory of Dissociation," by Prof. Dewar.
- FRIDAY, 5th.—Royal Institution, 8. "The Proper Motions of the Stars," by Professor R. Grant, at 9 p.m.
Society of Arts, 8. "Experiences of an European Zemindar (Landowner) in Behar," by James Mylne.
Geologists' Association, 8.
- SATURDAY, 6th.—Royal Institution, 3. "History of the Science of Politics," by Mr. F. Pollock.
Physical, 3. "On the Mercurial Thermometer," by F. D. Brown.

THE CHEMICAL NEWS.

VOL. XLV. No. 1171.

SOME OF THE DANGEROUS PROPERTIES OF DUSTS.*

By F. A. ABEL, C.B., F.R.S.,
President of the Institution of Chemistry.

WHEN dealing with the subject of so-called accidental explosions, in a discourse delivered to the Members of the Royal Institution, in March, 1875, the lecturer pointed out that combustible, and especially inflammable substances, if sufficiently light and finely divided to allow of their remaining for some time suspended in air in considerable quantity, so as to form an intimate mixture with it, may, when ignited in this condition, produce explosive effects. The combustion of the finely-divided particles which, under such conditions, are first inflamed, at once communicate flame to those in their immediate vicinity, and combustion is thus transmitted by and through the surrounding mixture of dust and air with a rapidity regulated by the inflammability of the dust, and by the proportion and state of division in which it is distributed through the air. If a rapidly-burning mixture of this kind is confined, its combustion will be attended by explosive effects, the degree of violence of which is determined by the combustibility of the dust, by the quantity of mixture ignited, and the nature of its confinement. Its behaviour is indeed quite similar to that of a mixture of inflammable gas or vapour and of air; at the instant of its ignition each dust-particle is to a more or less considerable extent converted into inflammable vapour, or is, at any rate, surrounded by an envelope of burning vapour, so that if the particles are in sufficiently close proximity to each other, the rapidly successive development of vapour from them as the flame spreads, gives rise to a condition of things very like that which obtains when an inflammable gas, or vapour, originally existing as such, is mixed with air.

Even the most inflammable solid, in the form of dust, must be mixed in large proportion with air, must, indeed, be present in the form of a dense cloud, in order that the transmission of flame may proceed continuously from the portion first ignited to surrounding parts of the mixture. A dense cloud of Lycopodium dust in air will transmit flame with rapidity and violence throughout its whole extent, but if the particles in the cloud be not in very close proximity, the application of flame to it will only produce short flashes in the vicinity of the source of flame, and the fire will not spread to surrounding particles.

The difficulty of maintaining, if only for a brief period, a sufficiently uniform and highly charged mixture of air with even a very light inflammable powder, to ensure the propagation of flame through it, and the circumstance that, with powders which are not very highly and completely inflammable, only some portion of the combustible matter is actually burned when flame is applied to the mixture of dust and air, necessitate the presence of a proportion of dust more or less considerably exceeding that which is proportionate to the oxygen supply in the volume of air with which it is mixed, if flame is to be transmitted by the mixture.

This condition is not difficult of fulfilment in practical operations in which inflammable dust is dealt with, and flame may consequently be transmitted upon a large scale through mixtures of inflammable dusts and air, with a

rapidity calculated to produce more or less violently explosive effects, as has been demonstrated by many accidents in works where manufacturing operations have been attended by the production and escape into the air of large quantities of inflammable dust. The accidental inflammation of sulphur dust in chambers in which its pulverisation has been carried on, has given rise to more than one considerable and somewhat violent explosion. Cotton mills have been known to become rapidly fired by the ignition of, and transmission of flame by, mixtures of cotton dust and air, and very quickly spreading conflagrations originating from dust explosions have occurred in other works dealing with even less inflammable and dust-producing materials; thus, at the Garancine Mills, at Sorgues, an explosion occurred in 1878, consequent upon the ignition of a mixture of air with the dust of that substance. But the most numerous and extensive calamities connected with the accidental ignition of mixtures of light inflammable dust and air have occurred in flour- and rice-mills.

The cause of many disastrous explosions and fires which occurred in flour-mills at Budapest in Hungary, at Frideat in Germany, in other parts of the Continent, and in England, prior to 1872, appeared enveloped in much mystery, until Dr. Watson Smith directed attention to the fact that an Austrian observer had apparently traced their origin to the ignition, by flame or some incandescent body (such as sparks produced by the millstones), of mixtures of air and the dust of meal and husks formed during the grinding of corn or subsequent treatment of flour. The occurrence of a very serious explosion and fire at the Tradeston Flour-Mills, in Glasgow, in January, 1872, caused that gentleman to direct public attention to what appeared the true explanation of these disasters, and on the occasion of that catastrophe, when several persons were killed and a number injured, the subject was carefully investigated by Messrs. Rankin and Macadam. The origin of the explosion was conclusively traced to the striking of fire by a pair of millstones, through the stopping of the feed, and the consequent friction of their bare surfaces against each other; the results being the ignition of the mixture of air and fine flour dust by which the millstones were surrounded, and the rapid communication of flame thereby to the mixture of dust and air which filled the conduits in communication with the exhaust box: this being the common receptacle into which the mixture of dust and air is drawn, by an exhaust fan, through the conduits communicating with the several mills. From the exhaust box, where a portion of the suspended flour dust was deposited, the air, still laden with dust, passed, in the Tradeston as in other flour-mills, to another chamber, called the stive room, where a further quantity of the flour dust would deposit. A connected series of channels and larger enclosed spaces was therefore filled with a dust-laden atmosphere, through which flame was so rapidly transmitted from the millstones where the first ignition occurred as to produce violent explosive effects, which succeeded each other with very great rapidity in different parts of the building. The production of the blaze at the millstones was observed to be immediately succeeded by a crackling noise as the flame rapidly spread through the conduits to the exhaust box upon an upper floor, whence a loud report almost at once proceeded.

Messrs. Rankin and Macadam's inquiries elicited the facts that other flour-mill explosions had been attended by a similar succession of effects to those above indicated, and that at the Tradeston Mills themselves a less violent explosion, resulting in the bursting open of an exhaust box, attended by injury to some workmen, and the blowing out of windows and loosening of tiles, had taken place on a previous occasion. In the later accident, the more violent explosion of the exhaust box was followed by other distinct explosions in distant parts of those extensive mills, to which fire was led by the dust-laden air existing in the many channels of communication, and i-

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 28, 1882.

which the cleansing and sifting operations, all attended by the escape of dust, were carried on.

Messrs. Rankin and Macadam ascertained that accidents of this nature at flour-mills were of frequent occurrence, especially since the exhaust arrangements had been applied to the larger flour-mills, and in their report they point out that it seems scarcely possible to guard against such accidents, though their frequency may be reduced by adopting efficient precautions for avoiding the stoppage of the feed to the millstones and the access of nails or other iron particles to the stones; and by prohibiting the employment of naked lights in the vicinity of the mills or dust passages. They also suggest that measures should be taken to reduce, as far as possible, the violence of explosions and the risk of injury to life and property, by constructing all receptacles into which the dust-laden air is drawn or passed from the mills, &c., as lightly as possible, so as to offer little resistance to the sudden expansion due to the ignition of an inflammable mixture, and by placing such receptacles as the exhaust box and stive room outside the building.

Since the publication of Messrs. Rankin and Macadam's valuable report, the accidents at flour mills appear, however, to have been scarcely less numerous or disastrous than before the date of the Tradeson catastrophe. Thus, in September, 1874, a similar, though less serious, explosion occurred at the Port Dundas City Mills; and in May, 1878, another flour-mill explosion, quite unparalleled for its destructive effects, occurred at Minneapolis, Minnesota, where eighteen lives were lost and six distinct corn-mills were destroyed. Mr. Peckham, writing after the event from the University at Minneapolis, states that two dull explosions rapidly succeeding each other were heard by him, and on looking towards the manufacturing part of the city a large volume of black smoke was seen to envelop the spot where the Washburn A Mill stood, a column of smoke being at the same time projected to a height of several hundred feet. A storm was blowing at the time in the direction from the Washburn Mill to other mills in the neighbourhood, and in about five minutes from the time that the explosion was heard five neighbouring mills, with adjoining premises, were in flames. Persons who were in close vicinity to the scene of the calamity at the time of the first explosion heard a succession of sharp hissing sounds, doubtless caused by the very rapid spread of flame through the dust-laden air in the passages leading from the mills to the exhaust-box, and, at the instant of the explosion, the Washburn A Mill was observed to be brilliantly illuminated from top to bottom. The nearest mill to the latter was 25 feet distant, and appears to have exploded directly the flames burst through the first mill. The explosion of a third, 25 feet distant from the second, followed almost immediately; and the other three mills, about 150 feet distant in another direction, were at once fired. Windows were thrown out of buildings about a quarter of a mile distant, consequent upon the back rush of air following the explosion, and portions of the building materials were projected to very considerable distances. The cause of the explosion was carefully enquired into (by Messrs. Pick, Peckham, &c.), and it was attributed to fire being generated by the stoppage of the feed to a pair of stones, or by the accidental passage of some very hard substance between them. The consequent explosion of dust-and-air mixture round the stones and in the communicating passages added, by its concussion, to the quantity of dust suspended in the air in different parts of the mill, and a second more violent explosion was thus immediately brought about. The attention of Professor Lawrence Smith was directed to the subject of flour-mill explosions by this accident, and in a letter to M. Dumas, of May 4th, 1878, which was published in the *Annales de Chimie et de Physique*, he states his conviction, based upon experimental enquiry, that such accidents are due to the formation of explosive mixtures of finely-divided organic matters (such as flour) with the air, and refers to this as a "revelation" of the existence of a previously unknown

danger connected with an important industry, being apparently unaware of its elucidation by Rankin and Macadam, and Watson Smith in 1872.

Attention has again been recently directed to this subject of flour-dust explosions by a fatal and extensive calamity of the kind which occurred at a flour-mill at Macclesfield in September, 1881, and has been made the subject of an interesting report to the Home Secretary by Mr. T. J. Richards, of the Board of Trade, in which he confirms the conclusions of Messrs. Rankin and Macadam, and repeats the recommendations made by them.

In this particular case, again, there appears to have been no doubt that the inflammation of the dust and air mixture surrounding a particular pair of millstones was due to the stones remaining empty for some time, sufficient heat being consequently developed to ignite some portions of flour-dust existing between the bearing surfaces. One of the owners of this mill deposed that he had seen flame produced by stones when remaining empty, and that the appearance of the stones in question convinced him that flame had been thus produced. A very dry grain was, moreover, being ground at the time of the explosion. A strong consensus of opinion appears to exist that it is very difficult, with the best arrangements for feeding the millstones with grain, to guard against their running empty occasionally, and there is no doubt that on these occasions portions of flour are exposed to heat sufficiently great to char and sometimes even to ignite them. In connection with this effect of the heat to which portions of flour may be exposed between "dry" stones, the opinion of an "experienced person" (quoted as a regrettable one by Mr. Richards) deserves not to be lost sight of. It is to the effect that a stive room can at all times be safely entered with a naked light "except when there is observed the peculiar odour which is noticed there when one of the millstones has been previously running empty." It is not difficult to demonstrate that fine flour very thickly suspended in air will produce with the latter an inflammable mixture, through which flame will be rapidly transmitted: there is also no doubt that if, as is frequently the case, the enclosed dust and air mixture in the air-passages of a mill is somewhat warm, the propagation of flame through the mixture will be facilitated. But experimental observations which the lecturer has had occasion to make in connection with another branch of the subject of this discourse, lead him to consider it not impossible that the development of even very small quantities of inflammable gas or vapour from flour particles which become heated between "dry" stones to an extent to be charred, may, in some cases, decidedly facilitate the propagation of flame by a particular mixture of dust and air, which might otherwise only be bordering upon an explosive mixture.

Mr. Richards calls attention, in an appendix to his report, to four very disastrous fires which had occurred in flour-mills at Wakefield, York, Liverpool, and Deptford, within two months of the completion of his report, the origin of the fire being in each case unknown. There is no doubt that the number of fires occurring in corn- and rice-mills, the origin of which is wrapped in obscurity, is very great; and it is stated upon good authority that only about 20 per cent of the explosions in flour-mills which can be actually substantiated are made public, the miller being unwilling to direct increased attention to the risks of his business, which, as it is, have given rise to the establishment of high rates of insurance upon corn-mills. If efficient measures can be adopted in mills for preventing the dispersion of fine flour-dust by other than the comparatively imperfect contrivances for promoting its partial deposition (as in the exhaust box and stive room), flour-mill explosions will certainly be reduced in frequency and importance. The efficiency of at any rate one simple device for arresting the dust, by a species of filtration of the air which is removed from the millstone chambers, seems to have been already decisively demonstrated by practical results, and there appears reason to hope that the millowner will ere long have no valid excuse for per-

mitting a continuance of conditions favourable to what have appeared to be hidden risks of danger to his property and to the lives of those whom he employs.

There appears no doubt that some instances of explosion or of very rapidly spreading fire in flour-mills have been ascribable to the employment—accidentally, or with the permission of those in authority—of naked lights in the vicinity of particular parts of the factory where dust may be thrown into the air in large quantities. An explosion from this cause occurred at the mills of Messrs. Ellis and Co., of Bradford. A spout from a sieve having become choked, a man removed the lid; a quantity of dust at once flew out, and the mixture, meeting either a lamp in the man's hand or a naked gas flame close by, exploded, rendering the man insensible; the flame passed along an enclosed belt to a box containing a fan which was driving a blast of air into five purifying chambers: these purifiers were fired simultaneously, and the explosion then passed to the adjacent exhaust purifiers, and thence to the dust room, so that the mill was fired throughout almost immediately. In another instance the floor of a meal chamber broke, letting through the flour, which, on falling into the air, was ignited by a flame in the vicinity, and speedily fired the mill. Judging from statements made at a recent meeting of the National Association of British and Irish Millers, the opinion is entertained by many millowners that the running of millstones empty must not be credited with too great a share in the origination of explosions or fires in mills; but that many are caused by the so-called accidental ignition (by naked flames) of dust and air mixtures. If such be the case grave responsibilities are incurred by millowners and managers who permit the existence of lights other than safety lamps in localities where there is any possibility of a considerable quantity of dust becoming suspended in the air, or do not establish and strictly enforce regulations prohibiting the carrying of naked lights in or near any working part of the mill.

The important part played by coal-dust, which exists in greater or less abundance in all coal-mine workings, in aggravating and extending the injurious effects of fire-damp explosions, was originally pointed out with great force by Messrs. Faraday and Lyell, in the report which they submitted to the Home Secretary, in 1845, on the explosion at the Haswell Collieries in September, 1844, and on the means of preventing similar accidents. It does not come within the scope of this discourse to examine into the chief part of this most interesting and instructive report, which deals exhaustively with the cause of the explosion and the means of guarding against the recurrence of such a calamity; but the lecturer, having had occasion to study carefully what has been published on the subject of coal-mine explosions and their causes within the last three years, cannot forbear pointing out that the observations and conclusions published by Faraday and Lyell thirty-seven years ago have been repeatedly re-clothed with the garb of originality by workers who have but extended and amplified the original observations of those eminent men.

After discussing the subject of the accumulation of fire-damp in the goaves of the mines, its dislodgment by the drawing of jads, by falls of the roofs in the goaves, and by changes in atmospheric pressure, its diffusion into the surrounding air in the mine-ways, its ignition by a defective lamp, and the spreading of the flame to the gas-mixture, with which the goaf was charged, the reporters say—"In considering the extent of the fire from the moment of the explosion, it is not to be supposed the fire-damp was its only fuel; the coal-dust swept by the rush of wind and flame from the floor, roof, and walls of the works would instantly take fire and burn, if there were oxygen enough present in the air to support its combustion; and we found the dust adhering to the faces of the pillars, props, and walls in the direction of and on the side towards the explosion, increasing gradually to a certain distance as we neared the place of ignition. This deposit was in some parts half an inch, in others almost an inch thick; it ad-

hered together in a friable coked state. When examined with the glass it presented the fused round form of burnt coal-dust, and when examined chemically, and compared with the coal itself reduced to powder, was found deprived of the greater portion of the bitumen, and in some instances entirely destitute of it. There is every reason to believe that much coal-gas was made from this dust in the very air itself of the mine, by the flame of the fire-damp, which raised and swept it along, and much of the carbon of this dust remained unburnt only for want of air.

"At first we were greatly embarrassed by the circumstance of the large number of deaths from choke-damp, and in the evidence that *that* had been present in very considerable quantities compared with the small proportion of fire-damp, which, in the opinion of those in and about the works just before, must have occasioned the explosion. But, on consideration of the character of the goaves as reservoirs for gaseous fuel, and the effect of dust in the mine, we are satisfied that these circumstances fully account for the apparent discrepancy."

On January 17th, 1845, Faraday delivered a discourse to the members of the Royal Institution, in which he dealt with the substance of the above report, and with the experimental inquiry made by himself with reference to the provision of means for preventing a recurrence of such disasters as that at Haswell. In a brief account of this lecture published in the number of the *Athenaeum* following its delivery, the substance of his remarks relating to the effect of coal-dust is given in these words:—"The ignition and explosion of the (fire-damp) mixture would raise and then kindle the coal-dust which is always pervading the passages, and these effects must in a moment have made the part of the mine which was the scene of the calamity glow like a furnace."

(To be continued.)

ANALYSIS OF BEET-ROOT AND SORGHUM CANE.*

By P. CASAMAJOR.

In the United States, for the last twenty years, many attempts have been made to manufacture sugar, in a commercial way, from beet-root and from the sorghum cane. Such attempts continue to be made at this day, and although there is no predicting what results may be obtained in the future, I believe that heretofore these attempts have not been successful.

There are many persons who believe that cane-sugar can be made commercially from the sorghum cane, while others believe that beet-root is preferable to sorghum. The partisans of beet and those of sorghum differ widely in their estimates of the comparative values of these two sources of sugar. There is only one way of settling the question, which is to produce beet or sorghum which will yield good results. I have had occasion to examine several samples of beet-root raised in the Northern States, and one of sorghum, and the results obtained were in all cases very unfavourable.

The object of this communication is to call attention to the processes by which we may ascertain beforehand the quantity of sugar which may be obtained from a given weight of beet-root or of sorghum cane. It is nearly useless to try to ascertain the yield of a saccharine juice by experiments on a small scale, as such experiments never yield results analogous to those which can be obtained on a large scale with improved apparatus.

Beet-root or sorghum cane can only be considered by the sugar manufacturer as so much raw material. To estimate the value of either, the manufacturer should follow exactly the course that a refiner follows to ascertain

* A paper read before the American Chemical Society, December 1881.

the commercial value of a raw sugar. A refiner knows that, from a given quantity of raw sugar, he can obtain a certain portion of pure or nearly pure sugar, and a certain quantity of molasses, which will not yield any crystallisable sugar. Therefore, if he can ascertain the total quantity of sugar in raw sugar, and the portion which will remain in the molasses, the difference will be the pure sugar which he will obtain in refining.

It may be urged that account should also be taken of a certain quantity of sugar lost during the process of refining, but this loss is due to causes entirely independent of the composition of any raw sugar under examination, and it should be left out of the calculation.

The composition of molasses from a well-regulated sugar-house is pretty nearly constant. If raw cane-sugars are used in a refinery, the composition of the molasses which will not yield any sugar crystals will be very nearly as follows for a syrup of density equal to 40° Baumé:—

Sugar	37.5
Soluble impurities..	37.5
Water	25.0

A refiner may obtain, as residue, a syrup containing a smaller percentage of sugar, but we may assume, for the purpose of comparing one sample of raw sugar with another, that the above will be the composition of the molasses obtained in refining.

For the sake of convenience, in comparing one product with another in a sugar refinery, the composition of each product is sometimes stated in the *dry state*, or on the supposition that the product contains no water. Water is easily added, and it may be taken away by evaporation without affecting the quantity of pure sugar obtainable from a given commercial sugar. The quantity of sugar in a product reduced to dryness, compared to the total substances, is called *coefficient of purity* or *quotient of purity*.

Referring to the composition of the sugar-house molasses given above, we may see that its *coefficient of purity* is 50, which means that in cane-sugars 1 per cent of soluble impurities prevents the crystallisation of 1 per cent of sugar.

It has been argued that the coefficient of purity of molasses is not a safe guide for calculating the yield of pure sugar from a given sample of raw material.

There would be some foundation for this if the coefficient of purity of the molasses of a given refinery varied within very wide limits. The contrary is, however, the case. Thousands of tests, extending through several years, have convinced me that the coefficient of purity of molasses may be kept within very narrow limits. The coefficient is not always 50. Some refiners prefer to keep it somewhat lower; but the coefficient 50 answers very well for calculating the quantity of pure sugar obtainable from a raw cane-sugar.

To apply the above, let us suppose that we have a raw sugar whose coefficient of purity is 92. The composition of the sugar, supposed dry, would be—

Sugar	92
Impurities	8

As 8 parts of impurities prevent the crystallisation of 8 parts of sugar, the yield of the above dry sugar would be 92—8=84 p. c.

The results which can be obtained from a given weight of beet-root sugar are somewhat different from those which cane-sugar will afford. A series of tests made in the principal sugar-refineries of Paris show that the coefficient of purity of beet molasses seldom goes below 52, and is generally 55. From this we may deduce the rule that in beet-root sugar 1 p. c. of impurities prevents the crystallisation of 1.2 p. c. of sugar.

The composition of sorghum molasses, from which all the crystallisable sugar has been separated, has not been ascertained, as far as I know. From the analogy between sorghum and the sugar cane we may assume that, for

sorghum sugar, 1 p. c. of soluble impurities prevents the crystallisation of 1 p. c. of sugar.

The difficulty with beet-roots and sorghum cane grown in this country is principally that the coefficient of purity of their juices is not sufficiently high. Whenever a product is obtained whose coefficient of purity is high enough, the quantity of juice in a certain weight of roots or of cane may be ascertained, and this presents no difficulty. If, however, the coefficient of purity is not sufficiently high, there is no use in making further determinations, as there cannot be any profit in working a juice of low grade.

The coefficient of purity of a juice is determined very quickly and accurately by using a process which I first described in the *American Chemist* for October and November, 1873. This process is described more fully and in better form in the *Moniteur Scientifique* for March, 1877. In a late book on sugar analysis, published by Van Nostrand, it is said that this process is advisable when a balance is not at hand, but that it does not give as satisfactory results as Balling's process, which is mentioned as the *direct* process.

As my process is in use in most of the important refineries in the United States, I do not feel called upon to defend it. A constant use of it for several years shows that the results it gives agree within at least 1 per cent, and generally within less than ½ per cent. This process is founded on this—that the pure sugar in 100 c.c. of a solution is given by multiplying the indication of the optical saccharometer by 0.26048 when a Ventzke instrument is used, or by 0.1635 for the Duboscq saccharometer. On the other hand, the total quantity of substance in solution is represented by the degree Balling, multiplied by the specific gravity.

The coefficient of purity is obtained by dividing the first product by the second. If we call the saccharimetric test S, the specific gravity P, and the Balling degree B, we shall have coefficient of purity =

$$\frac{S \times 0.26048}{B \times P}$$

This may be written—

$$S \times \frac{0.26048}{B \times P}$$

If for every degree Balling we calculate the quantity—

$$\frac{0.26048}{B \times P}$$

we may form a table of factors by which to multiply the saccharimetric degree to obtain the coefficient of purity of a solution.

We may, instead of the Balling degree, determine the specific gravity, and, for any specific gravity, use the factor corresponding to—

$$\frac{0.26048}{B \times P}$$

In the articles above referred to tables are given for Balling degrees between 5° and 15°, and for Geisler's specific gravity spindle, ranging from 1.005 to 1.1050. For any other degree Balling, or any other specific gravity, the factors may be easily calculated from the formula given above.

The specific gravity may be determined by a balance, and the factor may be obtained by the following formula, in which the Balling degree does not enter:—

$$\frac{0.1}{P - 1}$$

in which P is the specific gravity. This is for Ventzke's instrument. For the Duboscq saccharometer the factor is given by—

$$\frac{0.0628}{P - 1}$$

To test a lot of beets for coefficient of purity the juice should be taken so as to represent the average juice of the lot. A wedge-shaped piece should be cut out of every

root picked out for analysis. The thin edge of the wedge should be at the axis of the root, and the angle of each wedge should be the same for every piece. All the wedges may be rasped on a common grater, and the pulp obtained should be pressed in a cloth so as to obtain the juice. This is immediately neutralised with lime, and heated, by which a thick black precipitate is obtained. The liquid, after filtration, is light and clear enough to be placed in the tube of the optical saccharimeter. The density of the filtered liquid should be taken to determine the coefficient of purity, as the juice of beets can always be defeated with a little lime.

The juice of sorghum cane is easily obtained by crushing with a hammer and wringing the cane with the hands, if no special apparatus is at hand.

If the coefficient of the purity of a juice is sufficiently high, we may in the next place determine the quantity of juice in a certain weight of the raw material.

The quantity of juice in the pulp obtained by rasping may be got at by drying a certain weight of the pulp and determining the water in the pulp by loss. We also determine the water in the juice by taking the difference between 100 and the Balling degree. As all the water in the pulp is in the juice, we have—

$$\text{p. c. juice in the pulp} = \frac{\text{p. c. of water in the pulp}}{\text{p. c. of water in the juice.}}$$

As to what constitutes a sufficiently high coefficient of purity, this should be left to the judgment of the parties interested. I may, however, call attention that in the North of France, in 1879, a beet was not considered as fit to work for sugar, the coefficient of purity of whose juice was below 79. For 100 parts of dried juice the composition would be—

Pure sugar	79
Impurities	21

We have seen that in beet juice 1 part of impurities prevents the crystallisation of 1·2 parts of sugar; therefore the yield would be—

$$79 - (21 \times 1\cdot2) = 79 - 25\cdot2 = 53\cdot8 \text{ p. c.}$$

I have had occasion to analyse several samples of beet-roots grown in the United States. Those which gave the highest coefficient of purity were from Delaware, the coefficient of purity of the juice being 63 per cent. The yield of sugar of the dried juice would be—

$$63 - (37 \times 1\cdot2) = 63 - 44\cdot4 = 18\cdot6 \text{ p. c.}$$

Most of the beet-roots I tested had a coefficient of purity below 50, and they could not, therefore, yield any sugar.

The coefficient of purity of the juice of a sorghum cane which I tested lately was 44, and of course no sugar could be obtained from this juice.

It is almost unnecessary to state, in conclusion, that the processes described are applicable to the sugar cane, and to other plants with saccharine juices.

ESTIMATION OF CHLORINE WITH THE AID OF GOOCH'S METHOD OF FILTRATION.

By DAVID LINDO.

It is generally considered that chlorine can be estimated with great exactness by the gravimetric method.

Chloride of silver being slightly soluble in water, especially in hot water, a small minus error may occur if the latter is employed to wash with, but this can be prevented by adding a little nitrate of silver to the water, as recommended by J. P. Cooke (CHEMICAL NEWS, vol. xlv., p. 235).

On the other hand, the precipitate retains occluded matters with great force. Error from not completely removing these often more than compensates for slight loss

occasioned by the use of hot water alone, or merely acidulated with nitric acid, or by the manipulations necessary when paper filters are employed.

According to Fresenius ("Quantitative Analysis," Seventh Edition, p. 170) we can, with great care, always obtain by this method 99·9 to 100·1 for 100 parts of chlorine taken. I presume Fresenius means when using paper filters, in which case the time required to make an estimate is generally six hours.

The limits of error here laid down are often reached, according to my experience, when paper filters are employed, and no silver nitrate added to the wash water.

Though sufficiently near for most purposes, greater accuracy in chlorine estimates may sometimes be desired. By adopting Gooch's method of filtration and Cooke's suggestion, with a few other simple precautions, a much higher degree of accuracy can be attained with less manipulation and expenditure of time than by the usual method.

This is shown in the results given below, obtained in estimating the chlorine in a very pure sample of chloride of potassium.

The sample had been prepared with care from purified chlorate of potash. I failed to detect any trace of impurity in 2 grms. of it submitted to a searching examination.

As about 0·5 grm. was used in each analysis, if any impurities were present the quantity must have been too minute to affect the results in the slightest degree. Ten grms. of the nitrate of silver employed were also examined. Except a minute trace of what appeared to be lime, no impurities were found. The solutions used in the estimates contained 1 grm. nitrate of silver in 20 c.c.

The perforated platinum crucible employed was of the following dimensions:—Height, 1 inch; diameter at top, 1 inch; diameter at bottom, $\frac{1}{2}$ inch. It had a light dish-shaped cover, and when in use was fixed in a hole made in a vulcanised india-rubber stopper, which had been previously digested at a gentle heat for some time in a solution of potash, to remove loose particles of sulphur from the surface.

A 10 per cent solution of the KCl was prepared, the salt and water being accurately weighed. To test its correctness a weighed portion was evaporated to dryness, with due precaution, in a Lawrence Smith crucible, gently ignited, and weighed.

Weight of solution taken 5·2962 grms.

Weight of residue 0·5296 "

The following atomic weights were employed:—

Chlorine	35·46
Silver	107·93
Potassium	39·13

being the numbers adopted by Fresenius.

Method.

Weighed the solution in a light glass stoppered bottle, and turned it into a deep porcelain capsule, about 4½ ozs. capacity, provided with a well-formed lip and a handle. Rinsed the bottle with 25 c.c. distilled water. Added solution of nitrate of silver in about the proportion of 25 c.c. to 0·5 grm. KCl and 2 c.c. pure nitric acid, sp. gr. 1·2. Heated to boiling-point, and kept at this temperature for some minutes without allowing violent ebullition, and with constant stirring, until the precipitate had assumed the granular form. Allowed to cool somewhat, and then passed the fluid through the asbestos.* Washed the precipitate by decantation with 200 c.c. of very hot water, to which had been added 8 c.c. nitric acid and 2 c.c. dilute solution of nitrate of silver containing 1 grm. of the salt in 100 c.c. of water. The washing by decantation was performed by adding the hot mixture in small quantities at a time, and beating up the precipitate

* The pump must always be started before connected with receiver

well with a thin glass rod after each addition. The pump was kept in action all the time, but, to keep out dust as much as possible during the washing, the cover was only removed from the crucible when the fluid was to be run in.

Put the capsule and precipitate aside, returned the washings once through the asbestos so as to obtain them quite clear, removed them from receiver, and set them aside to recover excess of silver. Rinsed receiver, and completed the washing of the precipitate with about 200 c.c. of pure cold (29° C.) water. Half of this was used to wash by decantation; the remainder to transfer precipitate to crucible with the aid of a trimmed feather, and finish the washing in the crucible, the lumps of chloride of silver being broken down with the glass rod. Removed the second filtrate from receiver, and passed about 20 c.c. 98 per cent alcohol through precipitate. Dried at 140° to 150° C.

Exposure for half an hour to this temperature was found more than sufficient to dry the precipitate completely, and rendered a second heating and weighing quite unnecessary.

Twelve consecutive experiments by this method gave the results recorded below. The estimates were all made at night, the time required for each being about an hour and a half, drying included.

Nos.	Weight of KCl taken in Grms.	Weight of AgCl obtained.	Per cent of Cl.
1	0.50115	0.9635	47.55
2	0.50638	0.9735	47.54
3	0.54416	1.0465	47.56
4	0.49092	0.9439	47.55
5	0.49369	0.9492	47.55
6	0.50778	0.9763	47.55
7	0.49563	0.9529	47.55
8	0.54491	1.0477	47.55
9	0.45678	0.8782	47.55
10	0.46154	0.8873	47.54
11	0.51290	0.9864	47.56
12	0.51412	0.9886	47.55

Average 47.55.

Theory requires 47.54 Fresenius.

Do. 47.59 Miller.

The precipitate admits of very accurate weighing; no desiccator is required. The film of moisture which all bodies condense on their surfaces having been deposited by allowing the precipitate to cool completely, no further absorption takes place.

The precipitates were very white after drying, and dissolved in strong solution of ammonia without residue. On melting in porcelain they lost weight only to the extent of three-tenths of a milligramme for each gramme.

The loss by washing with 200 c.c. cold water (29° C.) was found by experiment to amount to about two-tenths of a milligramme with precipitates weighing about a gramme. No correction is therefore required, as the two slight errors about balance each other.

It might be supposed that, after washing so persistently with the hot mixture, very little pure cold water would be required to remove remaining traces of impurity. In previous experiments, however, in which 100 c.c. of cold water were used, the precipitates (each weighing about a gramme) sometimes showed faint purple spots on drying, and the results were generally slightly above the truth; yet, I should state that in those experiments care had not been taken to granulate the precipitates before washing them.

Four estimates were made of a sample of HCl solution, the specific gravity of which, at 27° C., was 1.090, indicating 18 to 19 per cent of HCl. The results are given below.

Nitrate of silver solution was used in the proportion of about 19 c.c. for each gramme of the HCl solution taken: 200 c.c. of the hot mixture and 200 c.c. of cold water were used to wash with in each analysis.

Wt. of HCl Solution taken in Grms.	Weight of AgCl obtained =	HCl	Per cent.
1.8356	1.3451	= 0.342058	18.635
2.0272	1.4854	= 0.377737	18.633
1.4659	1.0742	= 0.273169	18.635
1.8513	1.3570	= 0.345085	18.640

Falmouth, Jamaica, B.W.I.,
April 5, 1882.

NOTE.—The Editor will be pleased to receive the further communications promised by Mr. Lindo on this method of analysis.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING MARCH 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
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and C. MEYMOTT TIDY, M.B., F.C.S.,
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To the RIGHT HONOURABLE THE PRESIDENT OF THE
LOCAL GOVERNMENT BOARD.

April 3rd, 1882.

SIR,—In this, our fifteenth monthly report, we lay before you the results of our analyses of the 189 samples of water collected by us during the month of March, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 189 samples, three were recorded as "slightly turbid," and five as "very slightly turbid." The remaining 181 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from March 1st to March 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 27 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the West Middlesex Company the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 27 samples from the mains of the Grand Junction Company, two were found to be "slightly turbid," and two "very slightly turbid," the remaining 23 samples being well filtered, clear, and bright.

Of the 27 samples from the mains of the Southwark and Vauxhall Company, one was recorded as "slightly turbid," and three as "very slightly turbid." The remainder were well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

So much stress being often laid upon the excess of organic matter commonly alleged to be present in the

water-supply of London, we would call special attention to the results of our determinations of organic carbon made during the past three months. The average amount of organic carbon found in the 23 samples of water examined for this constituent in January was 0.196; that found in the 23 samples examined in February, was 0.150; and that found in the 27 samples examined in March was 0.144 part in 100,000 parts of water; showing a gradual decrease in the proportion of organic carbon, and consequently of organic matter with the advance of the season. Taking the whole of the 73 samples of water examined for organic carbon during the period of January 1st to March 31st, the average proportion amounted to 0.162 part in 100,000 parts of water. Multiplying this proportion of organic carbon by 24, to get roughly the proportion of organic matter, the average quantity of organic matter is in this way found to constitute 1/100th of a per cent of the water; or to amount to somewhat over a quarter of a grain (0.28 grain) per gallon. Calculating on the same basis, in one sample only of the 73 did the quantity of organic matter amount to half a grain per gallon, and in two other samples only did it approach to that proportion.

Taking into consideration this freedom from excess of organic matter, and the general excellence of the water in respect of clearness and absence of colour, and more especially its state of abundant aëration, we would endorse the opinion of the Royal Commission, who last reported on the subject, to the effect that the water supplied by the London Companies is "perfectly wholesome and of suitable quality for the supply of the Metropolis."

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON THE DETERMINATION OF PHOSPHORUS IN IRON.

By J. LAWRENCE SMITH, Louisville, Ky.

IN recent years it has been a matter of considerable interest to determine the amount of phosphorus in the iron used in the arts, especially in that form of it known as pig-iron; in fact, since the manufacture of steel by the process of conversion known as Bessemer process, it has become a necessary procedure to ascertain the peculiar fitness of the cast-iron for this purpose; and has a bearing also upon the commercial value of pig iron. It is not many years ago that a few thousandths in the difference in the amount of phosphorus in two lots of pig-iron had but little effect upon its commercial value, while now, its presence affects it to the extent of several dollars value per ton.

Formerly but little reliance was to be placed upon the analytical estimate of the amount of these small percentages of phosphorus in iron, and uniform results were not furnished by different analysts. It was not until the use of an acid solution of molybdate of ammonia* was employed, that reliable results were to be had. Many years previous (in 1852), when I established the constant presence of phosphorus in meteoric iron, I was obliged to devise a process which, while it gave very good results, was not applicable to the present use.

The so-called molybdic acid process did not at first satisfy all chemists, and in hands of all did not give the uniform results desired, and even at the present time, modifications are constantly being sought after.

The molybdic acid process, as first used, was to precipitate the phosphorus from a nitric acid solution

of the iron by an acid solution of the molybdate of ammonia, re-dissolve the molybdate of ammonia in ammonia, and precipitate the phosphorus by chloride of magnesia and ammonia, and estimate the amount of phosphorus from the phosphate of magnesia.

The reasons for not estimating the phosphorus by the first molybdate precipitate were, first, the supposed indefinite nature of the precipitate, and secondly, the occasional presence of free molybdic acid in the precipitate; it was also recognised that the large amount of iron in the solution interfered materially with the precipitation of all the phosphorus, and it was made very apparent that the phosphorus must be concentrated into a small portion of the iron before commencing the process of analysis.

With these facts well established to my mind, I have been engaged off and on for two or three years examining the question of the determination of phosphorus in iron and steel, making several hundreds of variously modified experiments, and repeating the details of processes adopted by different chemists.

I first tried the solution of from one to three grms. of iron or steel in aqua regia, and precipitating by the molybdic solution, with all the iron present and without separating the silica; but the process gave no satisfaction, whatever way the phosphorus was ultimately weighed; nor did the evaporation to dryness over a water-bath and re-dissolving with a little nitric acid materially improve it. It became very evident, as already recognised by several English and American chemists, that silica must not be in the solution in which the molybdic precipitate was made; and, furthermore, that the larger portion of iron must be eliminated from the solution before this precipitation was attempted. The chemist of the Burdon Iron Works, Troy, and of the Pennsylvania Central Railroad gave me their experience on the subject.

In describing the following method, ultimately adopted as affording the most speedy and accurate results, I give but little else than slight modifications of methods already employed by others, with such detail of manipulation as facilitates uniform method of operation.*

Quantity of Iron employed.—It is customary to employ 1 gm. for pig iron, and 2 to 3 grms. for malleable iron and steel; but in my own practice I employ but 1 gm. for all varieties of iron; for even where the iron or steel contains one-thousandth and less of phosphorus, I get as satisfactory results as where 2 and 3 grms. are employed.

Solution.—The iron, say 1 gm., is placed in a porcelain capsule of about from 100 to 150 c.m., and 3 or 4 c.m. of water added; the capsule is placed on a water-bath, and 10 to 15 c.m. of aqua regia is added little by little; the aqua regia is prepared in advance in the usual way with 2 parts chlorhydric acid and 1 part nitric acid. The contents of the capsule are now evaporated to dryness over the water-bath or more speedily on an iron-plate; the capsule with its contents is then placed in an air-bath and heated from 140° to 150° C. for from 30 minutes to 1 hour—thus rendering all the silica insoluble; 3 or 4 c.m. of chlorhydric acid with an equal quantity of water are added to the dry residue, and then warmed gently over a water-bath or lamp; the iron is re-dissolved, a little more water added, the solution filtered with the filter-pump; the filtrate placed on a narrow graduated measure of 100 c.m. capacity and sufficient water added to make the liquid contents 100 c.m.; the whole is well shaken to make the solution uniform. The next step is to concentrate all the phosphorus into a limited amount of the iron.

Concentration of the Phosphorus.—From 90 to 92 c.m. of the last solution is placed in a capsule of 300 or 400 c.m. capacity, either of porcelain or platinum—the latter I use by preference—and 100 c.m. of water added; the iron oxide is now reduced to iron protoxide by soda sulphite or

* Method of making described in "Fresenius's Analytical Chemistry."

* S. Peters has used a process nearly the same as the Burdon Iron Works, Troy

ammonia sulphite.* I prefer the latter, and prepare it in the manner mentioned in the note; the ammonia sulphite I used at the suggestion of Mr. S. Peters, which he stated to me was used advantageously by himself and others. Two or three centimetres of the ammonia sulphite is added to the iron solution and the contents of the capsule are boiled until all the sulphurous acid is driven off, this stage of the process being recognised by the sense of smell. By putting a small drop of the solution on the end of a glass stirrer into a weak ammonia solution we readily recognise the complete conversion of the oxide, for the precipitate is nearly white. Of course during the whole of the above process the solution is acid, with the excess of chlorhydric acid. Ammonia is now added slowly to the warm solution until a little of the greenish precipitate remains undissolved; about 20 c.m. of acetic acid is now added to the solution (which immediately re-dissolves the precipitate), and then 1 or 2 c.m. of ammonia acetate solution; finally, the 8 or 10 c.m. of original solution remaining in the graduated glass is added with 200 or 300 c.m. of water.

The whole contents of the large capsule is boiled gently from one-half to one hour, and if necessary the water renewed as it is evaporated. The result is the formation of a basic per-salt of iron containing practically all the phosphorus that was originally in the grm. of iron used.

Separation of the Phosphorus from the above Precipitate.—With a filter-pump on a $3\frac{1}{4}$ inch filter, the last precipitate is collected in 15 or 20 minutes; the precipitate is not washed, but a mixture of 5 or 6 c.m. of chlorhydric acid, with an equal quantity of water, is warmed in the capsule in which the boiling has taken place, so as to dissolve the adhering oxide of iron; the hot acid solution is thrown on the filter in the funnel, detached from the pump, the filtrate is readily dissolved and passes in some convenient vessel, and the filter washed once or twice; this solution is placed in a porcelain capsule and evaporated to dryness over a water-bath or on a hot plate. I prefer the former, although it takes a longer time. To the dry, but not over-heated residue is added 1 to 2 c.m. of nitric acid, with an equal quantity of water; this will furnish a clear solution if there be no titanium in the iron; if the latter be present, there will be formed a flocculent precipitate that can be readily separated by a filter prior to the last treatment.

The last Treatment.—The solution now need not be more 10 or 20 c.m. to which ammonia is to be added until the precipitate first formed is no longer re-dissolved; then add a few drops of nitric acid to clear up the solution completely, in which the phosphorus is supposed to have been concentrated. 30 c.m. of molybdic acid solution is now added to the last solution in a small beaker which is then warmed for 15 or 20 minutes to a temperature of 80° C., and agitated with a glass rod. The phosphorus is precipitated as the double ammonia-salt, and settles as a chrome-yellow powder in less than 30 minutes, and is ready for collection on a double filter,† although I commonly allow two hours or more time to elapse before filtering and washing with the filter-pump. As the filter is very small it is readily washed with a little distilled water.

After washing, the double filter is placed in an air-bath heated to about 120° C., and in about 30 minutes weighted by separating the filters, the complete dryness is verified by a second heating in the air-bath.

Of the phospho-molybdate every 100 m.g. will contain

* Equal parts of ammonia and water are placed in a bottle and an excess of sulphuric acid passed through; the operation lasts for several hours, using a mixture of charcoal and sulphuric acid. Once prepared it keeps very well, when kept from the light.

† When I filter a precipitate to be weighed on the filter, a double filter is used, each of the same size; they are weighed one against the other and exactly balanced by the weights; on the lighter one a + mark is put with pencil, and the number of m.g. that it is lighter than the other. As only a $2\frac{1}{4}$ or 3 inch filter is used, the difference in weight between the filters does not usually exceed 10 or 20 m.g. I always keep a number of these double filters (with the difference marked on them) ready for this purpose or any other.

1.63 m.g. of phosphorus, or 3.74 m.g. of phosphoric acid. The result of this method of analysis will indicate a very minute quantity of phosphorus less than what is contained in the iron, but so small as not to affect the practical result, and will be more accurate, certain, and speedy than if estimated as magnesian phosphate.

Cold-Short Iron.—It has been customary to attribute the cold-shortness of certain iron to the presence of phosphorus. Now, after working on this problem in rolling mills, I have found that the phosphorus cannot alone account for this peculiarity. Very often I have taken a 1 inch and $1\frac{1}{4}$ inch iron that was very cold-short and working them down to smaller sizes, as $\frac{1}{2}$ inch bars, &c., found that very good merchantable iron is produced, capable of being bent and forged cold or hot as well as any good quality of iron, although the phosphorus in the large and small iron is the same in quantity. I would not say that phosphorus has no effect on the cold-shortness of iron; but I would remark that whatever effect it has is very much modified by the manner of working the iron. And this opinion is sustained by that of others who have had much to do with the working of iron.—*American Journal of Science.*

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, April 22nd, 1882.

Prof. CLIFTON, President, in the Chair.

New Member, Dr. E. Hopkinson.

The PRESIDENT announced that copies of the Report of the Lightning-rod Committee could be obtained from Dr. Guthrie, Science Schools, South Kensington, price 5s. per copy.

A paper was then read by Mr. W. F. STANLEY, "On the Evidence of a Flowing Liquid moving by Rolling Contact upon the Interior Surface of a Pipe." In his experimental work on "Fluids," published last year, the author has endeavoured to show that liquids flowing in a tube move by rolling contact on or past the resistant surfaces of solids, and upon like principle that the moving parts of a flowing liquid move by rolling contact on the more quiescent parts of its own mass, so that in no case is there any element of sliding, gliding, or shearing motion, such as is generally assumed. Further experiments tend to support this view in the case of liquids flowing through pipes. The difficulty in the experiments arose from the friction of the pipe impeding the free motion of the particles. The principle was investigated by allowing liquids of various kinds—such as solutions of mastic varnish—to flow through pipes, the liquids containing colouring matter or air particles to assist the eye. The author illustrated the effects by diagrams on the screen.

Dr. W. H. Stone, Mr. Blaikley, Dr. Guthrie, and the President, offered some remarks on the paper.

Mr. J. M. WHIPPLE exhibited the magnetograph curves obtained at the Kew Observatory during the past week, showing the progress of the recent magnetic storms. After stating that two unusually large spots were now passing over the sun's disc, he remarked that although the magnets at Kew were somewhat disturbed on the 14th, they were nearly stationary until the night of the 16th, when about 11.45 p.m. they became strongly affected, and from then till 8 p.m. on the 17th the magnetic storm raged. The horizontal component of the earth's magnetic force was at one time reduced more than 0.05 m.m. (m.g.s.) below its average value, and the vertical component by about 0.07 of the same units. This happened about 6 a.m. of the 17th. A little after noon of the same day both forces became so increased that the light spot left the scale of the instrument for nearly two hours. A second riot of magnetic disturbance commenced at about

3.40 a.m. of the 20th, and was violent up to 2 p.m., subsiding gradually until 7.45 a.m. of the 21st. During this period the magnetic force, though fluctuating largely, did not experience such great changes of intensity as were indicated by that of the 17th. Mr. Whipple then alluded to the work of Prof. W. G. Adams, and suggested that sun spots only produced such effects when cutting certain lines of force, which he imagined might extend for a limited angular distance round the earth's radius sector.

Prof. ADAMS pointed out the desirability of increasing the number of self-recording magnetic observations, especially in the Southern Hemisphere; and after mentioning that the French were about to equip such an observatory at Cape Horn, expressed the wish that the Cape of Good Hope Observatory might again be provided with magnetometers.

The Rev. S. J. PERRY remarked on the exceptional nature of the storm which he had seen recorded at Brussels, and stated that in Belgium the telegraphic service had been disorganised by it. Attention was also called to the auroral displays in America.

Mr. Lecky, Dr. Guthrie, the President, and others spoke on the general phenomena of the storms.

It was then announced that the meetings of the Society in May would be held on the 6th and 20th instead of on the 13th and 27th, as previously announced; also that the Society would meet at the Clarendon Laboratory, Oxford, on June 17, by invitation of the President.

NOTICES OF BOOKS.

Modern Metrology: a Manual of the Metrical Units and Systems of the Present Century, with an Appendix containing a Proposed English System. London: Crosby Lockwood and Co.

We have here a work on a subject much neglected, and, in consequence, little understood, but by no means lacking in importance. We are, at present, as regards the question of measures, in a transition state. The inconveniences and complications of our old system are generally admitted, and there are many persons of authority in such matters who advocate the introduction of the French or metric system as the only alternative. It must be remembered, however, that whilst the general principles of a decimal division, and of a harmonious relation between the standards for lineal measure, capacity, and weight, are admittedly convenient, the metric system, as it now stands, and as it is used in France, Germany, &c., is open to certain objections. The metre is not, as was formerly supposed, the ten-millionth part of the length of a meridian from the Pole to the Equator, but a mere approximation, and consequently must be pronounced an arbitrary unit. "The unit of cubic measure, the litre, which was nominally the thousandth part of a cubic metre, at a later date lost its purely scientific and theoretical value by becoming a measure containing a kilo. weight of distilled water at 4°, while the measure itself was supposed to remain at 0° C."

The standard weight, the "kilogramme des archives," is, of doubtful value. Its nominal weight is of course 1000 grms., "whilst the calculated weight of a cubic decimeter of water, according to Stampfer in 1830, is 999.653 grms., and according to Kupffer in 1841, 999.989 grms."

But there are other disadvantages in the metric system as it now stands of a more practical nature. The names of our traditional weights and measures are short, and with few exceptions monosyllabic. If we look at a table of metric weights and measures, we find the grades expressed by words of three or four syllables. Some of the names, too, are liable to be confounded with each other, such as decimetre and decametre, decigramme and decagramme.

Again, the figures used in our ordinary system as factors

and divisors are small, and easily dealt with mentally. Two, four, six, eight, or ten ounces are magnitudes which persons of the meanest capacity can remember. But suppose we translate these quantities into their metric equivalents we get such figures as 58, 116, 174, 232, 290 grms.—numbers much less easily remembered. If we know the price of anything per pound we can easily calculate the price per quarter or half-pound. But the metric system, if carried out in its integrity, discards all save decimal fractions. As a writer in a contemporary remarks:—"The metric system in its present form brings us in contact with numbers beyond the reach of the multiplication table. The fact is that this system, as at present organised, is not so much decimal as centesimal or millesimal. In our ordinary system we can express very small quantities by whole numbers. A grain, a grain measure, a line, are quantities below which it is rarely necessary to go. The metric system requires plain, short, simple names for its various grades to be arranged in such a manner as to banish the decimal point beyond all ordinary transactions. It needs, too, names for the half, the quarter, &c., of its denominations."

Mr. Jackson quotes the opinion of the late Warden of the Standards—"There can be no question of the greater convenience of our Weights and Measures over those of the Metric System for the practical purpose of weighing and measuring; the units have been adopted as the most convenient, and our system is far better than the metric system; but for purposes of account it is inferior to it."

The author suggests, instead of either, an English decimal system. Its units are the inch, foot, and yard, with their squares and cubes. As the standard weight he takes a cubic foot of water, which "has been a legalised standard unit of weight since the year 1859, and its legally declared value at 62° F., barometer 30", is 62.3210 lbs.: taking the correct value of this unit at 32° F. as 62.4245 lbs., or 998.79 commercial ounces, its relation to the ounce of commercial weight is tolerably well established. This foot weight is the English *talent*, in the same way as the Greek *talant* was the weight of an Olympic cubic foot of water."

On this talent the author decimalises at intervals of 1000. The 1-1000th part of the talent is the scientific ounce, which differs from the commercial ounce merely by 0.12 per cent. The 1-1000th part of this ounce, the *mil*, is 0.43697 of a grain, and the 1-1000th part of the mil is the *doit* = 0.000437 of a grain. A unit of 1000 talents, the *thousand-weight*, is = 27.868 tons.

We like these short English names much better than the lengthy "classical" names of the metric scale. The author claims for his units the following advantages:—They are based on a recognised legal unit; they are transmutable into commercial units through the ounce by a reduction of 0.12 per cent; they are purely decimal; that conversion from weight to volume and from volume to weight is as practicable with them as with metric units; the actual weight of any body of known volume and density is easily ascertained. For example, the weight of 2 cubic feet of wrought iron having a specific gravity of 7.78 = 15.56 talents. The reduction of units of pressure in which these weight units are applied is as easily effected as with metric pressure units.

We commend this English scientific system to the careful examination of our readers. But whatever may be thought of this new series of units, or of the author's partial dissent from the metric system, it will be recognised that he has furnished a wonderfully complete survey of the weights and measures of all nations, ancient as well as modern. It will be found a valuable book of reference for men of the most varied pursuits. The merchant, the manufacturer, the lawyer, the statistician, the historian, the antiquary, and the divine, as well as the student of physical science, are often in need of information which they will be able to find here, and in very few other books. The chief defect we notice is the want of an index.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 16, April 17, 1882.

Transformation of Carbon Oxysulphide into Ordinary Urea and Sulphurea.—M. Berthelot.—Carbon oxysulphide and gaseous ammonia form, on combination, ammonium oxysulpho-carbamate, which is again transformable into urea by the simple elimination of sulphuretted hydrogen. This conversion is particularly distinct in presence of metallic oxides. If the aqueous solution of the salt is evaporated, there is formed a crystalline matter, formed of ordinary urea mixed with a notable quantity of sulphurea and a little ammonium sulphocyanide.

Pernitric Acid.—P. Hautefeuille and J. Chappuis.—Ozone prepared by the electrification of dry air is mixed with another gaseous compound, pernitric acid. The formation of this acid from a mixture of nitrogen and oxygen submitted to the action of the electric effluve, is limited like that of ozone, and the maximum corresponding to a given temperature may be fixed by the decrease of pressure to which the gaseous mixture is submitted. When the pernitric acid has acquired the maximum tension corresponding to the temperature of the experiment, the electric discharges decompose it into hyponitric acid and oxygen, as is shown by a sudden fall of pressure and by the deep red colouration of the gas. It is advantageous to effect the preparation of pernitric acid at low temperatures, whenever it is desired to obtain a gaseous mixture strongly charged with this acid.

Action of Ammoniacal Gas upon Ammoniacal Nitrate.—M. Raoult.—By the reaction in question there is formed a definite compound, $2\text{NH}_4\text{O}, \text{NO}_3 + 3\text{NH}_3$.

Certain Reactions of the Stannous Salts.—A. Ditte.—On pouring silver nitrate into an excess of nitrate of tin, there is produced an abundant grey precipitate, which, if washed and pressed between blotting-paper in the absence of light and dried in a vacuum, gives a grey substance, easily soluble in dilute nitric acid. It does not dissolve in ammonia, a trace of which colours it of a deep red. If the white precipitate is left in the liquid in which it has been formed it becomes red. If suspended in a large quantity of water it is transformed into a deep red powder, which, after washing and drying in a vacuum, is still insoluble in ammonia, but soluble in dilute nitric acid. It is silver meta-stannate. This compound, if heated, detonates, and is projected out of the tube. If the silver nitrate is in excess, the first drop of the tin-salt poured into it gives a pinkish white turbidity, which quickly turns red, and yields ultimately a deep red precipitate, almost black. The filtrate is at first colourless, but it quickly becomes turbid, and the same deposit is produced. The precipitate thus formed in presence of an excess of silver is, when washed and dried in a vacuum, a deep brown powder, insoluble in ammonia, but completely soluble in dilute nitric acid. It is a hydrated silver stannate, and does not deflagrate when heated. By adding silver nitrate very gradually to a very dilute solution of stannous nitrate, there is formed a reddish purple precipitate, which, when washed is a deep purple mass, which is soluble both in ammonia and in dilute nitric acid. The ammoniacal solution is of a deep red; if it contains but little silver it turns colourless on exposure to the air; if it contains a notable quantity of silver it evaporates without change of colour, and leaves a purple residue, which, if air-dried, retains all the properties of the original substance, and in particular its solubility in ammonia. Platinum chloride and palladium nitrate behave like salts of silver. These deeply-coloured stannates and meta-stannates are charac-

teristic reactions for the stannous salts. They are not formed in solutions of stannic chloride.

Tetra-nitrated Ethylene Bromide.—A. Villiers.—The author has studied the direct action of nitric acid upon various bodies of the fatty series, and has succeeded in obtaining the body above mentioned, $\text{C}_4(\text{NO}_2)_4\text{Br}_2$, by thus treating ethylene bromide.

Origin of Saccharine Matter in Plants.—A. Perrey.—The author concludes that glucose is not a product of the direct elaboration of chlorophyll. Cane-sugar, on the other hand, appears to be a product of the direct elaboration of the green cells.

MISCELLANEOUS.

Official Scientific Analyst.—The President of the Royal College of Physicians of London has nominated Dr. Stevenson, of Guy's Hospital, to the post of Scientific Analyst, to conduct any analyses of bodies of deceased persons that may be ordered by the Secretary of State in the interests of Justice, during the year beginning May 1st.

South London School of Chemistry.—The prizes awarded at the examinations held on the 4th, 5th, 13th, and 15th April, were presented to the following successful competitors on Tuesday, the 25th ult.:—Chemistry, Medal, Mr. Forster; Certificate, Mr. Woollons. Botany, Medal, Mr. Woollons; Certificate, Mr. Forster. Materia Medica, Medal, Mr. Burton; Certificate, Mr. Dillon. Pharmacy—Practical Dispensing, Medal, Mr. Birkbeck; Certificate, Mr. Burton. Certificates of Merit were also awarded to Messrs. Hornby, Roberts, Davies, Heald, Reade, Oldershaw, Brunton, Naylor, Capper, Wright, Tucker, and Taylor. All the candidates that presented themselves for examination during the week ending April 29th passed.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Sugar in Malt.—Will any of your correspondents give me the amount of sugar in malt, either per cent or per bushel? I believe Prout gives the amount very low, and his analysis being some years ago, there may be a more recent one.—R. MARSHALL.

MEETINGS FOR THE WEEK.

- MONDAY, May 8th.**—Royal Institution, 5. General Monthly Meeting. Society of Chemical Industry, 8. "The Condensation and Utilization of Sulphurous Acid," by Mr. F. Maxwell Lyte.
— Society of Arts, 8. "Book Illustration: Old and New," by J. Comyns Carr.
— Geographical, 8.30.
TUESDAY, 9th.—Institute of Civil Engineers, 8.
— Photographic, 8.
— Royal Institution, 5. "History of Customs and Beliefs," by Dr. E. D. Tylor.
— Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 10th.—Society of Arts, 8. "The Fish Supply of London," by Spencer Walpole, late H.M. Chief Inspector of Salmon Fisheries.
— Geological, 8.
— Microscopical, 8.
THURSDAY, 11th.—Royal, 4.30.
— Royal Society Club, 6.30.
— Royal Institution, 3. "The Metals," by Prof. Dewar.
— Society of Arts, 8. "The Recovery of Sulphur from Alkali Waste (Schaffner's Process): a Record of Recent Results," by Alexander M. Chance.
FRIDAY, 12th.—Royal Institution, 8. "Different Modes of Lighting," by A. G. Vernon Harcourt, at 9.
— Astronomical, 8.
— Quekett Microscopical Club, 8.
SATURDAY, 13th.—Royal Institution, 8. "History of the Science of Politics," by Mr. F. Pollock.

THE CHEMICAL NEWS.

VOL. XLV.



SOME OF THE DANGEROUS PROPERTIES OF DUSTS.

By F. A. ABEL, C.B., F.R.S.,
President of the Institute of Chemistry.

(Continued from p. 191.)

THE report of Faraday and Lyell was published in the *Philosophical Magazine* for January, 1845, and was followed by a letter from Faraday in the February number of the same publication, in which he referred to the lecture just delivered at the Royal Institution, and made further suggestions with respect to the method of ventilating the mines suggested in the report. But it appears that these publications remained long unknown in France, for in 1855 M. du Souich, Chief Government Mining Engineer of the Saint Etienne arrondissement, when referring to an explosion which had occurred at Firminy, advanced, as new, the view that the deposition of crusts of a light coke upon the props was due to dust which was swept up and transported to a distance by the violent current produced by the explosion, and which, being in part inflamed, would carry on and prolong the effects of the fire-damp. The fact that men near the pit's mouth received burns and other injuries, while others who were in workings near the seat of the explosion, but out of the main air current, escaped unhurt, was ascribed by him to this ignition and carriage of flame by dust. Had the results of the explosion been entirely due to the mine being highly charged with gas, the explosion must, be considered, have extended to those portions. On the occasion of two explosions in 1861, M. du Souich again dwelt upon his views regarding the part played by coal dust in increasing the disastrous effects of fire-damp explosions. In 1864-67, M. Verpilloux instituted experiments which led him to the conclusion that coal dust plays an important part in coal-mine explosions; the subject was also pursued by several other French mining engineers at about the same time, and especially by M. Vital, who made some experiments on a small scale, in 1875, in connection with an enquiry into the nature and cause of an explosion which had occurred the year before at the Campagnac Colliery, and in a part where no fire-damp had ever been detected. An examination for gas had been made by the overman with a Mueseler lamp just before a shot was fired, and after the first shot, a second shot was prepared and, the fuze having been ignited, the men retreated, when after a short interval, an explosion took place, and the men stated that they saw a body of reddish flame advancing upon them. After examining the nature of dust collected in the mine, and instituting some special experiments upon a very small scale for the purpose of ascertaining whether, and to what extent, the flame from a small charge of powder was lengthened, when projected, like the flame from a blown-out shot, into air containing fine coal dust in suspension, M. Vital concluded that very fine coal dust, very rich in volatile (inflammable) constituents, will take fire when raised by an explosion, and that portions of the coal are successively decomposed, yielding explosive mixtures with the air, whereby the fire is carried along; the intensity or violence of the burning being much influenced by the physical characters (fineness, &c.), of the dust. He also pointed out that an explosion of fire-damp, while taking place almost instantaneously, inflames or decomposes a

small quantity of coal dust raised thereby; explosive action being thus propagated after the fire-damp explosion has ceased. Soon after M. Vital's investigation of the subject, Mr. W. Galloway commenced a series of valuable experiments upon a larger scale, with the view of investigating the influence of coal dust in colliery explosions, and the results were communicated by him to the Royal Society in two papers in 1876 and 1879. The conclusions to which Mr. Galloway was led by the experiments described in his first paper were to the effect that a mixture of air and a particular coal dust which had been made the subject of chemical examination and practical experiment was not inflammable at the ordinary pressure and temperature, but that the presence of a very small proportion of fire-damp in the air, the existence of which could not be detected with a Davy lamp by the most experienced observer, rendered this dust inflammable, and caused it to burn freely with a red, smoky flame. From this it was inferred that an explosion, when originated in any way whatever in a dry and dusty mine, may extend itself to remote parts of the workings, where the presence of fire-damp was quite unsuspected.

In his second paper, Mr. Galloway shows that the return air of a fiery mine which, though furnishing no indication of the presence of gas when examined in the usual way (by means of a Davy safety lamp), might in his opinion contain from 2 to 2.5 per cent, may be rendered inflammable by suspending coal dust in it. He also described experiments by which it appeared to be demonstrated that the flame produced by the explosion of fire-damp in a particular part of a mine might be propagated, at any rate to some extent, by coal dust raised by the explosion and suspended in the air travelling through the mine, even in the complete absence of fire-damp in the air. The apparatus used by Mr. Galloway was constructed on a somewhat extensive scale. In connection with the channel or gallery through which a current of air, with or without coal dust in suspension was passed, was a receptacle in which a mixture of pit gas (from Llwynpia Colliery) and of air was prepared and exploded. The direct communication between the gas vessel and the gallery (representing a mine way) was only interrupted by a diaphragm composed of from 2 to 6 leaves of newspaper; this separator being burst through by the explosion of a mixture of nearly two cubic feet of fire-damp with the requisite proportion of air. The coal dust was placed on the floor of the gallery and upon certain shelves fixed in it. It appeared open to question whether, with the employment of this apparatus there was not a possibility of very small quantities of fire-damp penetrating, before the explosion, into the gallery from the explosive chamber, through the closing arrangement above alluded to, and whether the results obtained in the gallery might, consequently, be accepted as produced solely by the effect of the concussion produced and flame promoted by the gas explosion in the separate chamber.

In a paper just communicated to the Royal Society, Mr. Galloway argues that any amount of gas which may thus escape into the gallery must be altogether insignificant as regards any possible influence upon the results obtained.

The conclusion now arrived at by Mr. Galloway, as the result of continued experiments with this apparatus, of which he has just given a further account, and of his examination into the effects produced by the Penygraig explosion in December, 1880, and the Risca and Seaham explosions of that year, is confirmatory of that published by him last year, namely, that the very decided view which he first held, "that a mixture of air and coal-dust is not inflammable at ordinary pressure and temperature without the presence of a small proportion of fire-damp," has not been borne out by his further experiments, as he considers that he has now shown "conclusively that fire-damp is altogether unnecessary for the propagation of flame with explosive effects by a mixture of coal-dust and air," when the scale on which the experiments are made is large enough, and when the fineness and dryness of the dust are "unquestionable."

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 26, 1882.

This conclusion coincides in the main with that arrived at in 1878, as the result of experiments by Prof. Freire Marreco, conducted in connection with the North of England Institute of Mining and Mechanical Engineers, which Society, as well as the Chesterfield and Derbyshire Institute of Engineers, has laboured very usefully in this direction contemporaneously with Mr. Galloway. The most recent conclusions of the latter in respect to coal-dust were in fact forestalled by those which the late lamented Prof. Marreco, in association with Mr. P. D. Morison, communicated to the first-named Institute in November, 1878, and which were published in its *Transactions* of that date.

Messrs. Marreco and Morison's experiments were carried out in galleries or long boxes, representing mine workings, though on a smaller scale than Mr. Galloway's later apparatus, and constructed somewhat differently in their details. The apparatus used by them at Harton Colliery (and with which experiments have since been continued by Messrs. Lindsay Wood and G. May) was in fact a double gallery, so arranged that the air current which passed into one gallery made its exit at the end of the second, alongside the point of its first entrance. The mode of proceeding was to fire successively two powder shots, in different positions in the gallery box, from small cannon, so as to represent blown-out shots in the effects produced; coal-dust was placed upon the floor of the box, and one shot was first fired against the air current which was passing at a known velocity. The dust-cloud thereby raised was carried along by the current, and a second shot was fired into it, and in a large number of experiments made with many different descriptions of dust, the flame produced by the second shot was increased by that of inflamed dust, a comparatively clear flame being sometimes produced, while in other instances it was accompanied by a shower of sparks. The view taken by Vital, Marreco, and others, regarding the action of coal-dust in propagating flame in air free from fire-damp, is to the effect that the first portions of dust acted upon by the inflamed gases of the shot liberate inflammable gas which mixes with the air, and is fired, the non-volatile part of the coal being in part consumed and in part deposited as a feeble coke. Some examination of coked deposits of dust sent to Marreco subsequently by Mr. Galloway confirmed the observations originally made by Faraday and Lyell, that the coal-dust is in part submitted to destructive distillation during the progress of the flame through the dust-laden air. Marreco considers that, although a proportion of the heat developed by the burning dust is absorbed by the gasification of the coal-constituents, the heat of combustion of these suffices to leave a margin for the carrying on of the action from one particle of dust to another, provided these be in sufficiently close proximity to each other.

In the experiments made by the Chesterfield and Derbyshire Institute of Engineers, in a very long gallery, results were obtained very similar to those of Marreco and Morison, and it was also found that a lengthening of a gas flame, which was placed in the gallery, could be obtained by causing the current of air to carry with it thick clouds of some descriptions of coal-dust.

Many instances are on record in this country and others of the firing, with semi-explosive violence, of clouds of coal-dust, produced either in the open air or in localities where no fire-damp could exist, some portions of the mixture of dust and air having come into contact with a flame or fire. Thus Marreco and Morison mention a case of a considerable quantity of coal-dust, which had been accidentally thrown over some screens at a pit's mouth, flashing into flame as the dust-cloud came into contact with a neighbouring fire, and burning a man very severely; and another accident, which occurred in a stone-drift, where it was believed that no gas could possibly be present. A considerable body of rock was dislodged and coal-dust raised by the firing of a shot, the flame of which fired the air and dust mixture, with very mischievous results. From 50,000 to 60,000 cubic feet of fresh air were

said to be passing through the drift per minute when this accident occurred.

There appear good grounds for believing that, provided coal-dust be sufficiently fine and thickly suspended in the air, and of a readily inflammable nature, fire may travel to a considerable distance in the working of a mine, through its agency, in the complete absence of fire-damp. The effects of transmission of flame in this way would be decidedly different, and much inferior in violence, to those produced by an explosion of fire-damp and air, or of a mixture of these with coal-dust; the comparative suddenness of the gas explosion would produce greater destruction and less burning effects than the comparatively gradual explosion, or the rapid burning of a dust and air mixture. In the latter case, the coal-dust will generally be considerably in excess of the air needed for its combustion, so that, however finely divided, much will escape being burned, and may be only very partially coked; and it is conceivable that, as suggested by Mr. Galloway, a second rapid burning or semi-explosion may be caused by the inrush of air, following the first explosion, into the workings which may be thick with heated and only partially burned dust, some of which may still be incandescent.

Considering that, since first Faraday and Lyell directed attention to the dangers of coal-dust in mines, its behaviour has been made the subject of many series of experiments and published reports here and abroad, it is remarkable that in most instances of coal-mine explosions, until quite recently, the probable effect of coal-dust in increasing their magnitude does not appear to have received the serious attention which it merits at the hands of mine-owners and of those in authority connected with coal-mines. When the Royal Commission on Accidents in Mines was appointed, it collected evidence from H.M. inspectors of mines, from experienced colliery owners and mining engineers, and from selected pitmen, with respect to the causes of accidents, and that evidence included several statements regarding the possible influence of coal-dust in aggravating explosions, but the preponderance of opinion of H.M. inspectors was against the view that explosions could originate with, or be to any great extent propagated by, coal-dust in the absence of fire-damp. The only experiment on a practical scale bearing upon the subject which appears to have been made until quite recently is that of Mr. H. Hall, Mine Inspector of the North Wales, &c., District, who, in firing charges of 4 lbs. of powder from a cannon in an adit driven about 50 yards from the surface in a coal seam on the dip, coal-dust being sprinkled upon the floor, obtained flame extending to distances of 30 to 60 yards, while without the dust the flame of the shot did not extend more than 6 or 7 yards.* Some decided opinions were expressed that the supposed influence of coal-dust in aggravating explosions was over-rated, and that it would certainly not lead to explosions in the absence of gas. On the other hand, Mr. Galloway expressed a strong opinion that some of the most extensive of recent explosions, such as those at Llan and Abercarne, were at any rate largely contributed to by coal-dust, and more recently—on the occasion of the inquiry into the Penygraig explosion—he gave evidence to the effect that the disastrous results of this explosion were mainly, if not entirely, ascribable to the action of coal-dust, supporting this opinion by the results of a minute examination into the condition of the pit, of the sufferers, &c., after the accident.

When the terrible calamity which occurred at Seaham Colliery in September, 1880, was officially enquired into, the suggestion was very decidedly put forward by the miners' representatives, that the coal-dust which existed in large quantities in some parts of the mine, and especially near the spot where it was surmised that the explosion had originated, might have had much to do with the accident. Indeed the opinion was strongly entertained

* Mr. Hall stated that the air in this adit was "practically" free from gas, but did not maintain its absolute freedom.

by some that it was entirely due to the ignition of coal-dust, in the absence of gas, by the flame from a blown-out shot. The lecturer was consequently requested by the Home Secretary to make experiments with samples of dust collected in different parts of the mine, and the results obtained with them led to an extension of experiments with dust from other collieries in different parts of the kingdom. These experiments, carried to a certain point for the immediate purpose of the Seaham enquiry, have been interrupted for some time, but the Royal Commission has now resumed them with the object of obtaining more precise data in connection with certain results which were elicited by the first part of the investigation.

The earlier experiments were carried on at the Garswood Hall Colliery, where a constant and abundant supply of pit-gas (a so-called blower) is brought to the surface, and was kindly placed at the service of the Commission by Messrs. Smethurst and Co., together with many conveniences, for the purposes of these and other important experiments upon which they have been engaged. The apparatus used at Garswood for the experiments with the Seaham and other dusts, was similar in character to those employed by Freire Marreco, Galloway, and others, great pains being taken to secure accuracy and uniformity in the velocity of the air currents passing through the gallery, in the proportion of pit-gas, or fire-damp, used with the air, and in the intimacy of the mixture. In order to raise the air-current in the gallery to a temperature similar to that of the atmosphere in colliery workings, the air supply was drawn through a system of heated pipes, so that, when passing at as high a velocity as 1000 feet per minute, its temperature would be raised up to 80° or 85° F. even in the very severe weather during which some of these experiments were made.

The samples of coal-dust experimented with were examined with respect to fineness, proportions of volatile matter and ash, and one or two other points, and they were all carefully dried before use.

Experiments were made in the first instance with a view of ascertaining the smallest proportion of fire-damp which, when mixed with the air passing through the apparatus, would furnish an atmosphere capable of firing at a naked flame of a particular size, placed in the gallery. It was next ascertained what quantity of gas below that proportion was needed to impart to the mixture of air with a large quantity of each particular coal-dust the property of exploding throughout the gallery. By these experiments the samples were classed in the order of their sensitiveness to explosion, and it was found that those which were very rich in pure coal, and which contained the highest proportion of very fine dust were the most sensitive, *i.e.*, required the lowest proportions of fire-damp in air to bring them to explode readily when suspended in a dense cloud. But with the samples containing larger proportions of non-combustible matter the order of sensitiveness did not necessarily harmonise with the comparative richness of a sample in pure coal, nor with its comparative fineness, and this was strikingly illustrated by a sample of dust from one of the roads in Seaham Colliery, which contained more than half its weight of non-combustible matter, yet ranked only third in order of sensitiveness, while another sample, containing considerably more coal and a somewhat larger proportion of the finer dust, ranked fifth.

Another point clearly established, and confirming by more accurate data the observations of earlier experiments, was that the proportion of fire-damp required in a mine to bring dust into operation as a readily exploding material when thickly suspended in the air is bordering upon and even below the smallest amount which can be detected in the atmosphere of a mine, by the most practised observer, with the use of the Davy lamp, the only means of searching for gas which has until quite recently been employed in mines. The highest proportion which can thus be detected by an experienced operator is stated to be about 2 per cent

Explosions were produced by dusts suspended in air travelling at a velocity of 600 feet per minute, when fire-damp was present in proportions ranging from 2 to 2.75 per cent; in currents of low velocity the same result was produced with a sensitive dust in the presence of only 1.5 per cent of fire-damp, and ignitions which approached explosions in their nature and extended to considerable distances, were obtained with this dust in air containing still smaller proportions of gas. Mixtures of fire-damp and air bordering upon those which will ignite upon the approach of flame, were found to be instantaneously fired by a lamp if they contained only a few particles of dust in suspension; and in connection with this fact the interesting observation was made that such dust particles need not be inflammable nor combustible to produce the result named. Mixtures of air and gas which passed a naked flame without any symptom of ignition were inflamed when particles of a fine light powder, such as calcined magnesia, were suspended in them. The action of certain of the pit dusts which contain comparatively little coal, in determining the ignition of mixtures of air and small proportions of fire-damp, is possibly of the same character as the behaviour of such a dust as calcined magnesia. The power of favouring the ignition of mixtures of fire-damp and air was not exhibited by some other powders similar in fineness to the latter, but differing in structure and density from this and one or two other non-combustible dusts which may be called active; and even different samples of magnesia, differing somewhat in lightness from each other, appeared to possess the activity in different degrees. These facts seem to favour the view that a dust possessing particular physical characteristics exerts a contact or catalytic action upon gas mixtures, similar to that known to be possessed by platinum and some other substances under particular conditions. Thus, when finely-divided platinum, or even a clean recently-heated surface of the compact metal is brought into contact with mixtures of hydrogen, or of a hydrocarbon gas or vapour, with oxygen or air, oxidation of the hydrogen or hydrocarbon is at once established, accompanied by the development of heat, whereby the temperature of the metal is raised and chemical activity promoted, so that heat speedily accumulates, raising the metal to a temperature sufficiently high to bring the surrounding gas-mixture to the exploding point. If the metal presents a very large surface, or is in a specially porous condition, as in the form of sponge or very fine powder (*platinum black*), the explosion of the gas-mixture may follow very rapidly, or almost instantly, upon the first contact of some portion with it.*

In many of the experiments with calcined magnesia just referred to, it was distinctly noticed that a dark space intervened between the gas-flame used as the source of heat and the flare produced by the ignition of the gas-mixture through the influence of the dust cloud suspended in it, which would seem to indicate that the dust particles, immediately upon passing through the flame, established some amount of oxidation of the fire-damp, which proceeded with increased rapidity as the dust became more highly heated through the chemical action developed, so that within a short distance from the point where the heating commenced the dust became incandescent, and the ignition of the gas-mixture followed. Further experiments which are contemplated may elucidate the precise nature of this action of non-combustible dust in promoting the ignition of gas-mixtures which, in the absence of dust, are not inflammable. There appears little doubt, however, that it constitutes one element in the dangers arising from the presence of dust in the air of a mine which con-

* This action of platinum (or palladium) has recently received applications bearing special reference to the existence of explosive gas mixtures in coal-mines. The one consists in an apparatus proposed by Mr. Körner for removing, by slow combustion, local accumulations of fire-damp; the other is a very simple and portable photometric apparatus, devised by Mr. G. H. Liveing, by which proportions of fire-damp much lower than the smallest amount discoverable by the Davy lamp in the hands of the most expert, can be readily and quickly detected, and the amount estimated with considerable accuracy.

tains a small proportion of fire-damp, and in which a large body of flame is accidentally produced, either by a blown-out shot, or by a fire-damp explosion of local character.

(To be continued.)

ON THE SPECIFIC RESISTANCE OF MERCURY.*

By LORD RAYLEIGH, F.R.S., Professor of Experimental Physics in the University of Cambridge,
and MRS. SIDGWICK.

THE observations detailed in the paper were made with the view of re-determining the relation between the B.A. unit and the mercury unit of Siemens, *i. e.*, the resistance of a column of mercury at 0°, one metre in length, and one square millim. in section.

According to Siemens,

1 mercury unit = 0.9536 B.A. units,

and according to Matthiessen and Hockin,

1 mercury unit = 0.9619 B.A. units.

The value resulting from our observations agrees pretty closely with that of Siemens. We find

1 mercury unit = 0.95418 B.A. units.

Four tubes were used to contain the mercury, of lengths varying from 87 to 194 centims. The diameter of the three first tubes was about 1 millim. and that of the fourth about 2 millims. The final numbers obtained from the several fillings of the tubes are as follows:—

Tube I. ..	{	0.95386	}	0.95416
		0.95412		
		0.95424		
		0.95436		
Tube II. ..	{	0.95389	}	0.95419
		0.95414		
		0.95437		
		0.95436		
Tube III. ..	{	0.95424	}	0.95416
		0.95418		
		0.95399		
		0.95425		
Tube IV. ..	{	0.95440	}	0.95427
		0.95415		

Combining the results of the present paper with our determination of the B.A. unit in absolute measure we get

1 mercury unit = 0.94130 × 10⁶ C.G.S.

THE WATER SUPPLY OF THE CITY OF NEW YORK.†

By E. WALLER, Ph.D.

I DESIRE in the first place to present the results of complete analyses of the Croton water made at different times. The various denominations of salts present have been given, in order to more literally quote the different analysts. For the three first analyses double columns representing the results in grains per English Imperial gallon of 70,000 grains and in grains per United States gallon of 58,318 grains, the first columns in each case being the form in which the analysts have recorded their results to judge from the context. In Nos. 4 and 5 the magnesium and calcium bicarbonates have been calculated back to mono-carbonates, and the results given in brackets.

* Abstract of a Paper read before the Royal Society, May 4th, 1882.

† Paper read before the American Chemical Society, Feb., 1882.

Another table of the same results calculated to parts per 100,000 is appended.

There is probably less difference in the constituents of the water than the figures would seem to indicate, the mode of stating the results in the earlier analyses rather suggesting different modes of conducting the examination, and calculating results to those at present in use.

Next permit me to call your attention to a chart showing graphically the variations found in the constitution of the Croton water, by Dr. Chandler, during the summer months of 1867 and 1868, representing some fifty examinations, and my own results made in a similar manner from the latter part of 1872 to the middle of 1879, representing about 350 examinations. The average results may be thus stated:—

Average of Results on Croton Water in Parts per 100,000.

	Mineral Matter.	Organic and Volatile.	Total Solids.	Hardness.	Oxygen required.
Summer of 1867	6.72	1.12	7.84	4.32	0.181
" " 1868	5.66	1.97	7.63	—	0.168
Last 2 mos. 1872	7.48	0.44	7.92	3.553	0.131
Year 1873	6.23	1.59	7.82	3.395	0.135
" 1874	5.83	1.76	7.59	3.332	0.166
" 1875	5.656	1.835	7.491	3.293	0.211
" 1876	5.416	1.682	7.098	3.159	0.185
" 1877	5.603	1.823	7.426	3.260	0.253
" 1878	5.299	1.904	7.203	2.846	0.183
First 5 mos. 1879	5.424	0.912	6.336	2.811	0.072
Average from Nov., 1872, to May, 1873, inclusive—	5.702	1.678	7.380	3.210	0.180

The "Total Solids" were determined by weighing the residue obtained by evaporating a measured quantity; the "Organic and Volatile" by igniting the residue, moistening with carbon dioxide water, drying, and weighing again; the "Hardness" by soap solution as usual, the results being expressed in the equivalent of grains of calcium carbonate, while the permanganate test employed was that so frequently used,—acidification of a measured quantity of the water by sulphuric acid, and adding standardised solution of potassium permanganate until the colour held for half an hour, the water being kept during the test at the ordinary temperature of the laboratory.

In addition to these several other examinations made at irregular intervals at other times than those specified above, might be quoted, but as they present no marked deviations from those quoted, I will not occupy your time with them.

As a sample of similar determinations made on samples of the Croton taken from different parts of the City at the same time, I would present the results obtained in the latter part of April of last year, when the odours in the water caused the suspicion that it contained some compounds dangerous to health.

	Mineral Matter.	Organic and Volatile.	Total Solids.	Oxygen absorbed. (Permanganate.)
No. 1. West 33rd St. . .	6.6	2.2	8.8	0.064
No. 2. East 34th St. . .	6.0	1.5	7.5	0.060 F
No. 5. West 131st St. . .	4.4	1.3	5.7	0.064 F
No. 8. East 122nd St. . .	5.7	trace	5.7	0.062

The samples marked F were clarified by subeidence or filtration before examination, as they contained varying amounts of muddy sediment, and were therefore not fair samples of the water as ordinarily used. It may be mentioned that about a pint of No. 5, on standing about half an hour in a cylinder 2½ inches in diameter, deposited a sediment of about ½ of an inch in depth. When this sediment was distributed as evenly as possible through the water, and a portion examined, the results were:—

	Mineral Matter.	Organic and Volatile.	Total Solids.	Oxygen absorbed. (Permanganate.)
No. 2.	75.7	21.0	96.70	0.366
No. 5.	69.2	15.1	84.30	0.455

A portion of the sediment was examined separately; shaken with ether it afforded, as soluble in that menstruum, a minute proportion of vegetable wax, having a slight greenish brown tinge, probably from the presence of chlorophyll. A small amount was obtained for analysis, the results being:—

	Per cent.	Per cent.
Loss on ignition ..	23.31	
Silica	43.61 to 51.0	
Lime	0.63 =	CaCO ₃ .. 1.12
Magnesia	3.16 =	MgCO ₃ .. 6.64
Ferric and aluminic oxides	20.92	

As to other determinations on the Croton water, the following results may be offered (parts per 100,000):—

Date.	Free Ammonia.	Albumenoid Ammonia.	Remarks.
August, 1874	0.00095	0.0145	Average of 6
Dec., 1877	0.001	0.0102	" " 2
Nov. 16, 1878	0.0015	0.0130	
July 11, 1879	0.0008	0.008	
April 4, 1881	0.0020	0.0110	
" 22, "	0.0016	0.0117	" " 10
" 22, "		0.019 to 0.031	Total NH ₃ on very turbid samples.
May 16, 1881	0.001	0.007	
Nov. 8, 1881	0.002	0.012	
Nitrogen in Nitrates.			
July 29, 1881	0.0198		
Nov. 8, 1881	0.0181		

The results obtained on free and albumenoid ammonia do not indicate any material alterations in the proportions of those constituents for yielding nitrogen in those forms. The examination of last April shows that the quality of the water does not vary extensively in different parts of the city at the same time, unless the sediment is mixed in when the amount of nitrogen obtainable as ammonia by distillation may reach nearly thrice the amount obtainable from the sample when fairly clear. The amounts of nitrogen in nitrates, so far as they go, give no indications of sewage contamination in the water.

About the end of last year a paper by Prof. Leeds on "The Relative Purity of City Waters in the United States," was published in the *CHEMICAL NEWS*, vol. xlv., p. 265, in which the Croton water was condemned as polluted. The analytical results were given as follows:—

Croton, June 23, 1881. Results in Parts per 100,000.

Free ammonia ..	0.0027
Albumenoid ..	0.027
Oxygen required ..	0.81
Nitrites ..	none
Nitrates ..	0.8325
Chlorine ..	0.350
Hardness ..	3.30
Total solids ..	11.80
Mineral matter ..	5.00
Organic and volatile ..	6.80

These results I strenuously object to, first, because they are misleading. The term nitrates is indefinite, and when so many chemists calculate their results to nitrogen in nitrates, &c., the impression might readily be created that nitrogen in nitrates is meant by the above figure for nitrates. The "Oxygen required," as I have learned, was obtained by Kubel's method,—by reaction of potassium permanganate on the water strongly acidified with sulphuric acid at boiling heat. Inasmuch as most chemists (at least in English-speaking countries) make use of the permanganate test at ordinary temperatures, such a statement as the above without specifying the method used is calculated to convey a false impression of the quality of the water. Moreover, the test performed in that way is open to serious objection. Under those circumstances the

chlorine in the water would affect the results, and Prof. Leeds himself has shown us that the reagents used invariably contain impurities which would affect the test to the prejudice of the water tested, the permanganate containing chlorine compounds, and the sulphuric acid (which is used in considerable amounts proportionately) also containing nitrogen compounds, sulphurous acid, &c., and where a line is drawn on comparatively small amounts, the impurities of the reagents would make a great difference in the conclusions drawn.

Prof. Leeds's results on total solids and free and albumenoid ammonia are very high—indeed, higher than any results I have obtained during the past fourteen years, except when (as last spring) the samples of water were so charged with sediment as to render them by no means fair samples of the Croton water as ordinarily obtainable. The conclusion would seem to be that his sample was turbid with sediment. With regard to other determinations, they either agree with preceding examinations, or the methods employed were different from those of which I made use, and therefore preclude a comparison between them.

In commenting on the results, Prof. Leeds remarks: "New York and all the places mentioned lower on the list receive their water from contaminated sources. The feeders which empty into Croton Lake, the principal reservoir of the New York water, pass through a settled country, with numerous tanneries, factories, &c., along their banks. Analyses of the Croton water made at different times during the past five years, have shown that it is to be classed among contaminated water supplies." A quotation of this statement was sent to Mr. Isaac Newton, Chief Engineer of the Croton Aqueduct Depot. His reply was briefly to the effect that he had comparatively recently examined the Croton watershed, and that Prof. Leeds's assertion with regard to it was altogether erroneous. From other sources I have been able to ascertain, first, with regard to the population of the watershed, that for its area of 339 square miles the population is from 17,000 to 20,000, or about one man to every ten acres. Permit me to quote the table given by Mr. D. M. Greene, given in the "Twenty-third Annual Report of Water Commissioners of the City of Troy, for 1877," p. 120.

Population of Watersheds for Water Supplies of Cities.

City.	Pop. per Sq. Mile.
Rochester, N.Y. ..	36
New York, N.Y. ..	65
Albany, N.Y. ..	77
Poughkeepsie, N.Y. ..	80
Schenectady, Cohoes, and West Troy, N.Y. (Supply from Mohawk River) ..	103
Brooklyn, N.Y. ..	119
Boston, Mass. ..	229
London, England ..	270

Second, as regards industries in the Croton watershed. But few tanneries now exist in that region, for the simple reason that the most of the trees yielding the necessary bark have been cut down, and tanning is no longer profitable in that locality. As regards other industries the region contains but few factories of any kind, and those are on a small scale.

To sum up, then, I desire to express a most emphatic dissent from Prof. Leeds's conclusions, for the following reasons:—1. The proportion of chlorides existing in the water has not increased of late years, so far as the records extend, and hence no indications of contamination by sewage or manufactures can be asserted to exist. 2. The amounts of oxygen absorbed, by permanganate test for a number of years, serving to give a comparison of the quality of the water with itself at different times, show no changes in the quality of the water. The same may be said for the results on free and albumenoid ammonia and organic and volatile matter. 3. The Croton watershed is not crowded either with population or with

COMPLETE ANALYSES OF CROTON WATER.

Number—	1.	2.	3.	4.	5.	6.	7.
Analyst—	Prof. J. C. Booth.	Dr. J. R. Chilton.		C. F. Chandler.		E. Waller.	
Date—	1843.	1843.	August, 1859.	Summer, 1869.	May, 1872.	May, 1879.	Nov. 1881.
Gallon used—	Eng. U.S.	Eng. U.S.	Eng. U.S.	U.S. Gallon 231 cub. in. (583.18 gra.).			
Sodium chloride		} 0.44 0.367	0.404	0.336	0.402	0.284	0.205
Calcium sulphate			0.353	0.294	0.158	0.024	0.723
Alkaline chlorides	0.193 0.161						
Potassium sulphate					0.179	0.205	0.188
Sodium sulphate					0.260	0.024	0.200
Alkaline carbonates	0.828 0.690		0.270 0.225				
Magnesium chloride		} 0.90 0.750	0.147	0.122			0.054
Calcium chloride			0.104	0.087			
Magnesium carbonate	0.939 0.782	0.84 0.700	0.390	0.325	(1.101) (0.770)	0.918	0.685
Calcium carbonate	2.293 1.910	1.52 1.266	0.836	0.696	(1.648) (1.439)	1.650	1.319
Magnesium bicarbonate					1.913 1.338		
Calcium bicarbonate					2.670 2.331		
Ferric and aluminic oxide	0.110 0.092	} 0.46 0.383	0.170	0.142	trace	0.058	0.045
Silica	0.359 0.299				0.621	0.222	0.274
Organic and volatile	0.276 0.240		0.916	0.763	0.670	0.874	0.560
Total solids			3.590	2.990	6.873	5.360	
Solids by evaporation	4.998 4.174	4.16 3.466	3.705	3.087	4.780	2.849	4.893
Chlorine			0.354	0.296	0.243	0.172	0.124

Nos. 1 and 2. "Illustrations of the Croton Aqueduct, F. B. Tower, N.Y.," 1843, p. 135. No. 3. "Report of Water Commissioners of Albany for 1865," p. 50. Nos. 4 and 5. "Report of New York Board of Health for 1871," p. 371. No. 6. "Report on Croton Water, New York, 1881," p. 45.

COMPLETE ANALYSES OF CROTON WATER. RESULTS IN PARTS PER 100,000.

Number—	1.	2.	3.	4.	5.	6.	7.
Analyst—	J. C. Booth.	J. R. Chilton.		C. F. Chandler.		E. Waller.	
Date—	1843.	1843.	Aug., 1859.	Summer, 1869.	May, 1872.	May, 1879.	Nov., 1881.
Sodium chloride		} 0.629	0.577	0.690	0.487	0.351	0.351
Calcium sulphate			0.504	0.272	0.041	1.239	
Alkaline chlorides	0.276						
Potassium sulphate				0.309	0.351	0.322	0.345
Sodium sulphate				0.449	0.041	0.343	0.371
Alkaline carbonates	1.183		0.386				0.092
Magnesium chloride		} 1.286	0.210				
Calcium chloride			0.149				
Magnesium carbonate	1.341	1.200	0.557	(1.888)	(1.320)	1.575	1.174
Calcium carbonate	3.276	2.171	1.194	(2.826)	(2.467)	2.830	2.262
Magnesium bicarbonate				3.280	2.294		
Calcium bicarbonate				4.578	3.996		
Ferric and aluminic oxides	0.157	} 0.657	0.243	trace	0.100	0.300	0.078
Silica	0.513		1.060	0.060	0.380	0.470	0.360
Organic and volatile	0.394		1.309	1.150	1.500	0.960	0.400
Total			5.129	11.788	9.190		
Solids by evaporation	7.140	5.943	5.293	8.200	6.600	8.390	5.432
Chlorine			0.508	0.416	0.294	0.213	0.213

manufactures, as Prof. Leeds seems to imagine. 4. The health of the community is not and has never been such as to indicate the presence of any contamination in the water supply.

During the evening a ballot was held: Messrs. Groves and Makins were appointed scrutineers. The following gentlemen were declared to be duly elected Fellows of the Society:—L. W. Andrews, J. H. Beckett, J. H. Bicket, B. A. Burrell, J. Falkiner, G. R. Faulkner, W. J. Kemp, S. Langdon, E. G. Love, A. F. Price, W. H. A. Peake, A. N. Palmer, J. Robinson, S. P. Sadtler, W. C. Samuel, J. H. Smith, J. H. Stebbins, P. W. Squire, L. Taylor, G. Watson.

The President then called on Prof. DEWAR, F.R.S., to deliver his lecture "On Recent Developments of the Theory of Dissociation."

The lecturer said the title of the lecture was too extensive a one to be applied to his discourse, as he intended to describe a few only of the more important discoveries in this field of research. On a former occasion he had addressed the Society on the same subject, principally on the work of Deville. Since then mathematicians, by the aid of thermo-dynamical laws, had rendered the chemist a great service by systematising and classifying the phenomena, the discovery of which the world of science will

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 4, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE minutes of the previous meeting were read and confirmed.

The following certificates were read for the first time:—R. Alexander, G. J. Ellis, D. E. Johnstone, T. W. Lovibond, R. W. Pullar.

always associate with the name of Deville. The first chemist who studied chemical action as analogous to a physical change of state was Black. He had a great objection to hypothesis, and instead of calling his course Lectures on Chemistry, he designated them Lectures on the Effect of Heat and Mixture. Deville used the term dissociation to express chemical decomposition subject to certain conditions. A compound substance is said to be dissociated when the operation of decomposition is subject to the conditions—that the products of decomposition remain within the sphere of chemical action; and that the operation is reversible, in the thermo-dynamic sense of the term. The lecturer illustrated the phenomena of dissociation by showing the partial decomposition of iodide of mercury as the temperature increased, and the varying partial pressure of the ammonia evolved from the chloride of calcium compound. The stability of a body depends upon the temperature and pressure of the environment, where the medium in which the substance is placed is assumed to consist in part, of at least one of the gases produced by the dissociation of the compound.

Troost made experiments with calcium carbonate, and proved that the pressure of the CO_2 evolved is a function of the temperature, and is completely independent of the mass of lime or of calcium carbonate. When calcium carbonate is decomposed by heat we have to consider the effects of three bodies, carbon dioxide, calcium oxide, and undecomposed calcium carbonate. Now Troost proved three points:—(1) That the decomposition was a function of the temperature; (2) that the decomposition was independent of mass; (3) that the action is reversible, *i.e.*, the moment the temperature is lowered the partial pressure is also altered and re-combination takes place, so that the process resembles the condensation and volatilisation of a vapour. Deville proved that the temperature of the oxy-hydrogen flame was far below that indicated by theory, and he showed in the case of the flame of CO and O that the composition of the flame varied at different parts, so that in the hottest part there was most free oxygen. Deville also pointed out that experiments in which vapours were conducted along heated porous tubes, and so subjected to diffusion whilst dissociated, were only of value for showing that a certain amount of dissociation had taken place, and were valueless for determining the percentage amount of the dissociation. It was therefore impossible by such means to decide whether the substances were completely broken up or not.

The first exact determinations of partial pressures at various temperatures we owe to Isambert, who used the ammonio-chlorides of calcium and of silver. When these substances are heated, the partial pressure of the ammonia comes to a definite and fixed point for each temperature, if sufficient time be given to reach equilibrium. By numerous determinations a series of curves is obtained, showing the partial pressures at any temperature. Diagrams of such curves were exhibited, showing the curves of ammonio-chloride of silver, the ammonio-chloride of calcium, water, hydrogenium, &c. These curves all exhibit a different rate of increase as the temperature rises. As the temperature is raised the ratio of the increment of the pressure to the temperature becomes greater, until the curves become almost vertical. From such a table we can learn by inspection the pressure required to preserve any substance in a stable condition at any temperature. These bodies apparently follow a law similar to that of saturated vapours, but the true law is probably more complicated.

Recent investigations have shown that at a certain temperature chemical compounds behave like liquids and gases at the critical point. Thus if sulphuretted hydrogen and water be subjected to pressure, at low temperatures, a solid crystalline hydrate is formed; but if the temperature be kept at 40°C . no solid hydrate can be shown to exist, however great the pressure may be. Similar phenomena are observed with hydrochloric acid gas and phosphamine.

The lecturer then had shown on the screen two capillary

tubes, containing respectively hydrogen sulphide and water, and hydrochloric acid and phosphamine. To take the first of these mixtures: on applying pressure by means of a pump, similar to that used in Cailletet's apparatus, the hydrogen sulphide was first liquefied, and the water and the liquefied gas were seen one above the other: on increasing the pressure dark specks of the crystalline hydrate were seen; these gradually increased, until the whole tube became opaque. On decreasing the pressure these solid particles disappeared, and the tube became transparent. The experiment was repeated, with the tube surrounded with water at 40°C .; no solid hydrate was formed, although the pressure, as indicated by the gauge, amounted to 200 atmospheres.

Another experiment was here shown. Two transparent crystals of calcite were placed in two platinum crucibles raised just above the melting-point of zinc: through one crucible a current of carbon dioxide was passed, the other was exposed to the atmosphere; after some time it was seen that the crystal in the carbon dioxide remained transparent, the other had become partially converted into lime.

In the next experiment a current of hydrogen was passed over a bulb containing iodine gently heated; the mixed elements then passed through a coil of metal tubing heated to 250° to 300°C ., and a continuous formation of hydriodic acid was observed. If, on the other hand, hydriodic acid had been subjected to this temperature, it would have been partially decomposed into hydrogen and iodine. So that at the same temperature hydriodic acid may be both formed and decomposed. The action is reversible, and resembles the condensable state of a vapour. Moreover, in both cases—*i.e.*, whether a mixture of the elements or the compound be employed—the resulting mixtures of hydrogen, iodine, and hydriodic acid will be identical in composition, provided the temperature and pressure are the same, the combination or decomposition proceeding until an equilibrium is established.

The cycle of Carnot was explained, and Clapeyron's formula—applicable to all substances undergoing change of state at a constant temperature and pressure—deduced. The most convenient form of the equation is as follows ("Theory of Heat," Clerk Maxwell, Cap. VIII., On Heat Engines):—

$$\text{Molecular latent heat} = LD = \frac{T_2}{p} \frac{dp}{dt},$$

when the substance is transformed into the gaseous state at temperatures considerably below its critical point. By means of this formula the latent heat of volatilisation can be calculated. This is often of advantage to the chemist, as the accurate determination of latent heat is difficult. In order to test the application of this formula to dissociation phenomena, the amount of heat evolved or absorbed in the change (which in this case is called Heat of Combination) has to be calculated from this equation, by replacing the ratio of increment of pressure and temperature of the saturated vapour by a similar ratio deduced from the values of the tensions of dissociation for different temperatures. It is assumed that the transformation takes place at a temperature and pressure when the volume of the gas produced by the dissociation is very great in comparison with the volume of the non-volatile solid substance. When the formula is applied to carbamate of ammonia, hydrogen, or the ammoniac chlorides, substances whose tension of dissociation are known, the calculated and experimental values agree remarkably well. Calculated by this formula the number obtained per equivalent for carbamate of ammonia was 19,000, and the number by experiment was 19,047. This general formula holds good for chemical combination under the new conditions, as well as for physical changes of state.

The function expressing the relation between temperature and pressure of saturated vapour was considered, and the history of the differences detailed. Prof. Gibbs,

of Yale College, deduced from a generalisation of thermodynamical principles the general formula—

$$\text{Log. } p = A - B \log. t - \frac{C}{t}$$

is the simplest approximate solution of the problem for physical or chemical change of state, on the assumption that in the case of dissociation one of the components is non-volatile. If the dissociating substance exists entirely in the gaseous state, then Gibbs finds the following formula expresses the relation of the partial pressures of the components, viz.—

$$\text{Log. } \frac{P}{(p_1 + p_2)^2} = -A' - B' \log. t + \frac{C'}{t},$$

where P is the pressure of the original substance, and p_1 and p_2 that of the products of decomposition. It is worthy of note that the form of the equation is in both cases the same. Gibbs has shown that the last equation gives with sufficient accuracy the varying densities of such substances as peroxide of nitrogen, formic and acetic acids, and pentachloride of phosphorus. New density determinations of great exactitude are required to verify the above laws.

The researches of Andrews on the liquefaction of carbon dioxide were discussed. As the temperature rises the approximation of the liquid and gaseous state, in the isothermal lines of the diagram of carbonic acid, becomes more and more apparent, until above the critical point, at a temperature of 48°C ., the curve resembles almost completely that of a perfect gas. It is almost impossible to over-estimate the value of these researches. Prof. James Thomson suggested that the isothermal lines for CO_2 below the critical point are not discontinuous, but that the fluid at high pressure, and below the critical point, exists in three different states. The critical point could be calculated, and all the other variables of a gas, by means of Clausius's formula; and the lecturer hoped that by the determination of various constants similar laws might ultimately be applied to chemical compounds.

If we assume that our elements are compounded of elemental matter, which may have two or more essentially different forms, then we may extend the laws of observation to the discussion of this hypothesis so far as ascertaining the conditions which would regulate the transformations. Some experimentalists regard hydrogen as forming a basic substance through which new matter is compounded; and for the purposes of discussion this body may be taken as a provisional constituent. Now the stability of the element does not depend on the temperature alone, but also on the constitution of the gaseous atmosphere in which it is assumed to be dissociated. This fact has been entirely ignored, or rather not understood, by those who have discussed this subject on the basis of the developmental theory. If hydrogen is a constituent which becomes isolated from our elements at solar temperature, severance of the hydrogen will not take place provided the element is located in an atmosphere of hydrogen having a partial pressure in excess of that due to the dissociation tension for any given temperature. Now the solar atmosphere seems specially constituted to increase the stability of the presumably decomposable elements, because of the necessarily high relative tension of free hydrogen. It is evident we must consider thoroughly the physical laws of chemical action before we dare attempt to interpret the meaning of the recondite alterations which are revealed by spectral phenomena, and recent discussion has taught us that we are very far from being in a position to generalise in this field of research.

The President had listened with great interest to the masterly exposition which Prof. Dewar had given to the meeting of our present knowledge of dissociation, and especially the recent developments of this important subject. He trusted that there would be a good discussion.

Dr. SIEMENS had heard with the deepest attention the lucid and complete exposition of the critical state of

gaseous matter. It was impossible for him to follow the lecturer to the depths of mathematical formulae, and he would ascend into the higher atmosphere of solar and stellar space. He was glad to hear that Prof. Dewar did not agree with solar dissociation. He wished especially to draw attention to the effect of radiant energy on attenuated matter. He believed that each ray of the sun had precisely the same dissociating power as the sun itself, and if this matter could be raised to the temperature of the photosphere, in space dissociation must occur.

Prof. ODLING said that with regard to the effect of radiant heat on highly attenuated matter in effecting decomposition and dissociation, he remembered that when Sir W. Groves first showed the decomposition of steam by balls of platinum heated in the oxy-hydrogen flame, Graham was of the opinion that the decomposition was not effected by the heat, but by light, i.e., radiant energy.

Prof. DEWAR said that he only discussed the bearing of dissociation on the question of the stability of our chemical elements. As to the source of solar energy, he had no intention of controverting the views of Dr. Siemens on that subject. He would point out that light decompositions are, as a rule, not reversible, and he would caution chemists to walk warily when using such delicate means of research as spectrum analysis, and it was, above all, most important to study the changes produced in spectra by varying physical conditions.

After a hearty vote of thanks to the lecturer, the Society adjourned to May 18th.

PHYSICAL SOCIETY.

Saturday, May 6th, 1882.

Prof. CLIFTON, President, in the Chair.

New Member, Mr. W. H. Heaton.

Mr. LECKY described a form of battery arranged by Mr. A. R. Bennet, of Glasgow, at a cost of 6d. per cell. The vessel and electro-negative plate consists of an iron milk or meat tin, into which is placed a porous pot containing a zinc plate stuck in a paraffined cork cover, fitting the porous pot. A solution of caustic soda is the liquid. In it iron does not rust, and is electro-negative to zinc. The electromotive force is 1.23 volts, where the Daniell is taken as 1 volt, and the Leclanché as 1.30 volts. Iron filings round the iron plate facilitate depolarisation by the escape of hydrogen from their points. The cell pitted against a Leclanché was found to ring an electric bell even longer than the latter.

Prof. GUTHRIE (in the absence of Dr. F. D. Brown, the author) gave a summary of a paper entitled "Notes on Thermometry." This described a method of calibrating the tubes by means of a microscope having an extra half-lens before the object-glass, which focussed the end of the mercury column, whilst the other lens focussed the tube, so that no alteration of the focus of the microscope was necessary in making an observation. Dr. Brown also found that a constant zero temperature was better obtained from a mixture of ice and water than from drained ice, and that it was preferable to mix the ice with distilled water rather than ordinary water.

Acting on the suggestion of Dr. Guthrie, Mr. WHIPPLE, of Kew, had found that the ice itself might be from different sources without appreciably affecting the result. Mr. Whipple called attention to the change of zero in thermometers by heating, and recommended buyers to see that makers had not let them be heated after their calibration.

Mr. J. MACFARLANE GRAY suggested that the thermometers used by Regnault should be examined now, as our standards are based on his results.

Prof. CLIFTON pointed out that the half-lens in the microscope would probably distort the image of the mercury column.

Prof. GUTHRIE then read a paper on the repulsion of a suspended horse-shoe magnet by a rotating copper disc below it. He gave tables of quantitative results, and a plotted curve, showing that the repulsion varied as the square of the rate of rotation. For a surface velocity of the disc of 163 metres per minute, the repulsion was 0.41 grm.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, Monday, May 1, 1882.

THOMAS BOYCOTT, M.D., F.L.S., Manager, in the Chair.

THE Annual Report of the Committee of Visitors for the year 1881, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The real and funded property now amounts to above £85,400., entirely derived from the contributions and donations of the members.

Fifty-two new members paid their admission fees in 1881.

Sixty-two Lectures and nineteen Friday Evening Discourses were delivered in 1881.

The books and pamphlets presented in 1881 amounted to about 270 volumes, making with 623 volumes (including periodicals bound) purchased by the managers, a total of 893 volumes added to the library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretaries, Warren De La Rue, Esq., and William Bowman, Esq., to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following Gentlemen were unanimously elected as Officers for the ensuing year:—

President—The Duke of Northumberland, D.C.L., LL.D.

Treasurer—George Busk, Esq., F.R.S.

Secretary—William Bowman, Esq., LL.D., F.R.S.

Managers—Right Hon. Robert Bourke, M.P.; Thomas Boycott, M.D., F.L.S.; Joseph Brown, Q.C.; Warren De La Rue, M.A., D.C.L., F.R.S.; Colonel James Augustus Grant, C.B., C.S.I., F.R.S.; Hon. Sir William R. Grove, M.A., D.C.L., LL.D., F.R.S.; Right Hon. The Lord Claud Hamilton, J.P.; Cæsar Henry Hawkins, F.R.S., F.R.C.S.; Sir John Hawkshaw, F.R.S., F.G.S.; William Huggins, D.C.L., F.R.S.; John Fletcher Moulton, M.A., F.R.S.; Sir Frederick Pollock, Bart., M.A.; Mr. Henry Pollock; John Rae, M.D., LL.D., F.R.S.; William Spottiswoode, M.A., D.C.L., Pres. R.S.;

Visitors—John Birkett, F.L.S., F.R.C.S.; Mr. Charles James Busk; George Frederick Chambers, F.R.A.S.; Frank Crisp, LL.B., B.A., F.L.S.; Henry Herbert Stephen Croft, M.A.; Alexander John Ellis, B.A., F.S.A., F.R.S.; Mr. Charles Lyall; Robert Mann, M.D., F.R.C.S.; Henry Maudslay, M.D.; William Henry Michael, Q.C.; Hugo W. Müller, Ph.D., F.R.S.; Mr. Lachlan Macintosh Rate; The Hon. Rollo Russell, F.M.S.; John Bell Sedgwick, F.R.G.S.; Mr. George Andrew Spottiswoode.

OBITUARY.

MR. T. W. KEATES.

We much regret having to record the death of Mr. T. W. Keates, widely and honourably known as the consulting chemist and superintending gas examiner to the Metropolitan Board of Works. The deceased was a sound and judicious chemist, of great learning, wide experience, and strong common sense. Few scientific men were his equals in the difficult art of giving professional evidence before a court of justice, making the facts clear to the comprehension of judge and jury, and baffling the device

by which counsel too often seek to hinder the statement of the truth. All who have come in contact with the deceased gentleman, whether in his official or private capacity, will gladly bear witness to his candour, uprightness, his nice sense of duty and honour, and his utter freedom from those charlatanic arts by which inferior minds strive to win public attention.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 16, April 17, 1882.

Discovery of the Alkaloids derived from Animal Proteic Matters.—Armand Gautier.—Before the researches of the author and of the late Prof. Selmi, various experiments were made in the same direction. About the time when the chief organic bases were discovered, Schwanert obtained from human remains substances capable of neutralising acids. In 1856, Panum, a Dane, obtained from the putrid flesh of a dog a poisonous extract, which he named sepsine. He showed that this complex matter was due to purely chemical agents and not to microscopic organisms. In 1868, Bergmann and Schmiedeberg obtained from putrid flesh a nitrogenous crystalline body, to which they also gave the name of sepsine. A year later, Zuelzer and Sonnenschein extracted from corpses an alkaloid differing from the former, but poisonous and expanding the pupils. The author then gives the dates of his own discoveries and those of Selmi.

Chemical Monograph of the Cucurbitaceæ of Uruguay.—M. Sacc.—The author gives proximate analyses of the gourds consumed in Monte Video.

No. 17, April 24, 1882.

Researches on the Distribution of Heat in the Dark Portions of the Solar Spectrum.—P. Desains.—Not adapted for abstraction.

Separation of Gallium.—Lecoq de Boisbaudran.—We are often led to separate gallium oxide from other oxides by means of barium or calcium carbonate used in the cold. With barium carbonate sensible quantities of zinc oxide are precipitated, but the baryta is easily removed by means of sulphuric acid. Calcium carbonate throws down rather less zinc oxide, but the removal of the lime requires operations which complicate the process. For the alkaline earthy carbonates an advantageous substitute is found in cupric hydrate, which precipitates gallium oxide more completely, and does not carry down any oxide of zinc. The copper is then eliminated by sulphuretted hydrogen, the liquid being kept acid in order to prevent gallium being rendered insoluble by copper sulphide. The treatment with cupric hydrate takes place in heat. The mixture is filtered after a few minutes. One-sixth of a milligramme of gallium diluted in a strong solution of zinc is recovered without notable loss. Copper oxide likewise precipitates gallium oxide, and separates it as distinctly from zinc oxide and from ferrous oxide. The solution is first reduced by boiling with finely-divided metallic copper; a small excess of cuprous oxide is then added, and after one or two minutes the liquid is rapidly filtered. It is practically difficult to avoid the peroxidation of a little iron during the filtration. Hence the treatment must be repeated several times, which does not cause an appreciable loss of gallium. The cuprous oxide used must be perfectly free from organic matter. The author corrects his former statement on the action of metallic cadmium upon gallium chloride. The reaction is

not complete, for a blade of zinc placed in the filtrate separates appreciable traces of gallium oxide.

Actinic Transformation of the Mirrors of Foucault and their Application in Photography.—M. de Charbonnet.—M. Cornu has shown that platinum in layers of complete transparency, unlike mirrors of polished silver and surfaces of silver deposited chemically, proves an excellent reflector for the ultra-violet rays. Foucault placed before his telescopes a plane glass covered with a semi-silvering so thin as to be transparent, but which preserved his apparatus by reflecting the non-luminous heat. This layer is therefore a *filter*, permeable to the dark rays alone, which may be used for photographing without the intervention of any visible ray of light.

Equivalent of Carbon determined by the Combustion of the Diamond.—Prof H. E. Roscoe.—The author has employed the same arrangements as MM. Dumas and Stas, but has used Cape diamonds instead of Brazilian specimens. Cape diamonds do not contain a trace of hydrogen, though they leave a little ash. If oxygen = 15.96, carbon becomes 11.07. M. Dumas, on communicating the above results, remarked that if oxygen is represented by 16, carbon becomes 12.002, that is a whole number within $\frac{1}{10000}$ th part.

Decomposition of the Lead Salts by Alkalies.—A. Ditté.—It is generally admitted that alkaline liquids in a slight excess determine in the salts of lead a white precipitate of hydroxide. In reality the reaction is less simple, and there are formed intermediate products, sometimes very difficult to decompose. If a certain quantity of lead chloride is suspended in water, and if potassa is gradually added, with stirring, the alkalinity quickly disappears after each addition, but the lead chloride is gradually modified. It turns slightly yellow, increases in bulk, and is finally changed into a white mass, which fills the whole liquid and is an oxy-chloride. After this moment the further addition of a trace of potassa gives an alkaline reaction to the liquid. If this oxy-chloride is carefully purified and suspended in water, the first portions of potassa added turn it slightly yellow; the liquid remains alkaline, and contains chlorine. But the proportion of chlorine varies but little on successive additions of potassa until the solution of the latter reaches the strength at which it decomposes the oxy-chloride. At this point the latter turns grey, and is quickly transformed into the anhydrous oxide.

Action of Sulphuretted Hydrogen upon Solution of Nickel Sulphate in the Cold.—H. Baubigny.—This memoir will be inserted at length.

Researches on Ozone.—M. Mailfert.—It is already known that sulphur is converted into sulphurous acid by ozone. If both are perfectly dry, no sulphuric acid is formed, but if the reaction takes place in presence of water, sulphuric acid only is obtained. If an alkali is present, a sulphate is formed. With selenium and tellurium ozone gives likewise, in presence of water, selenic and telluric acids. Neither selenious nor tellurous acid is formed. Most, if not all, sulphides are attacked more or less rapidly by ozone. The sulphides of copper, antimony, zinc, cadmium, as well as the alkaline and alkaline-earth sulphides yield sulphates. Nickel and cobalt sulphides are first converted into sulphates, but on continuing the reaction there is formation of peroxide, and a part of the sulphuric acid is set free. Gold sulphide gives a precipitate of metallic gold and sulphuric acid. Platinum, silver, and bismuth sulphides likewise give free sulphuric acid. Mercury sulphides are only slowly attacked by ozone. Manganese, palladium, and lead sulphides are converted into peroxides, and all the sulphur into free sulphuric acid. Formene and ethylene are converted into carbonic, formic, and acetic acids. Acetylene yields carbonic and formic acids, but not acetic. Amylene gives carbonic, butyric, and valeric acids. The formic and acetic acids, if present at all, are in very small proportions. Benzol and toluol yield carbonic,

formic, acetic, and probably other acids of the fatty series. Benzol gives also a dark brown solid, and toluol a brown syrupy liquid.

Absorption of Volatile Bodies by the Aid of Heat.—T. Schloesing.—The author remarks that the absorption of gases by reagents takes place in virtue of the mobility of their molecules. Only bodies whose molecules possess this mobility are capable of being absorbed by a short passage through a reagent. But in a great number of cases the volatile bodies which it is desired to absorb occur in the form of powders, liquid or solid, suspended in a gaseous medium. It is therefore proposed to facilitate the absorption of such matter by the application of heat, which may cause them to assume the gaseous state. The experiments described show the feasibility of this idea.

The Oxidation of Pyrogallol in an Acid Medium.—P. de Clermont and P. Chautard.—The authors conclude that the oxidation of pyrogallol in an acid medium by silver nitrate, chromic acid, and potassium permanganate is complex; the chief product of the reaction is purpuro-galline, $C_{26}H_{16}O_9$. On oxidising pyrogallol with permanganate mixed with sulphuric acid they obtained, in addition to purpuro-galline, pyro-gallo-quinone, and a third body not yet sufficiently examined.

Justus Liebig's Annalen der Chemie,
Band 211, Heft 2.

On Tolan-di-iodide.—E. Fischer.—This compound, $C_{14}H_{10}I_2$, is obtained by heating a dry mixture of both bodies up to the melting-point of iodine, dissolving out the unconverted matter in cold chloroform, and finally taking up the new compound in an excess of boiling chloroform, from which it crystallises out on cooling in rose-coloured leaflets.

Butylation of Aniline.—Arthur Studer.—The author examines the action of isobutylic alcohol upon aniline hydrochlorate, amido-butyl-benzol and its salts, butyl-phenol and its ethers.

Band 211, Heft 3.

Argentinian Quebracho Drugs.—O. Hesse.—An examination of various quebracho woods from a pharmaceutical point of view. He describes, as occurring in white quebracho, the alkaloids aspidospermine and aspidospermatine; aspidosamine, hypoquebrachine, quebrachine, and quebrachamine. In addition to these bases the author has obtained from the bark of the white quebracho an indifferent alcoholoid substance, quebrachol. The red quebracho (*Loxopterygium Lorentzii*), the species which is used in dyeing and tanning, contains a substance approaching catechine, and an alkaloid, loxopterygine.

Phytosterine and Para-cholesterine.—O. Hesse.—The author considers these two compounds as not identical.

Sodium Hyposulphite (Hydrosulphite).—A. Bernthsen.—A reply to M. Schützenberger on the disputed formula of this acid.

Succinyl- succinic Ester, the Product of the Action of the Alkali-Metals upon Succinic Ethyl-ester.—F. Herrmann.—The author describes this ester and its transformation-products, having a normal saturation-proportion of the carbon atoms; secondly, those transformation-products which may be deduced from a non-saturated carbon nucleus; and, lastly, the products which are to be considered as derivatives of quinone.

A Hydramide of the Fatty Series, Tri-iso-butyldiamine.—A. Lipp.—Not adapted for useful abridgment.

Normal Butyl-aldehyd-ammonia and Normal Amido-valerianic Acid.—A. Lipp.—The author gives a minute comparison between the properties of the latter acid and the corresponding iso compound.

A Correction.—J. W. Brühl.—The author points out an error in his memoir on the connection between the

optical and thermic attributes of bodies as printed in these *Annalen*, vol. 211, sec. 24, p. 164.

Communication from the Laboratory of the University of Wurzburg.—A. Emmert and F. Reingrubler.—This consists of a memoir on dimethyl-naphthaline as one of the coal-tar oils, boiling between naphthaline and acenaphthine.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., February, 1882.

Report presented by M. Dumas, on behalf of the Committee of Constructions and of the Fine Arts, on the Manufacture of Vitrifiable Colours.—M. Lacroix.—The Committee having recently inspected the works of M. Lacroix, describe their arrangement at some length. No facts of chemical importance are given.

Various Modifications of the Gramme Machine.—This paper cannot be intelligibly reproduced without the six accompanying illustrations.

Universal Exhibition of 1878: Colouring-matters and Colours.—M. Lauth.—The author describes phthalic acid, naphthol, naphthylamine, the pyrogallic and resorcinic phthalenes, the colouring-matters derived from azo-compounds, the indulines, the tropæolines, and artificial alizarine and its accompanying colours.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 13, 1882.

Dr. Miguel Fargas ascribes the aroma of roasted coffee to a peculiar principal, cafeone, which is developed in the act of roasting. Its action upon the heart is opposed to that of caffeine, as it increases the force and the frequency of its pulsations.

Macalline.—Dr. Rosado.—This alkaloid, obtained from the bark of the macallo, a tree growing in Yucatan, is recommended as superior to quinine in the treatment of intermittents. Neither the botanical name of the tree nor the composition and reaction of the alkaloid are given.

On Naphthol.—Savia Ambrogio.—The author finds that thymol may be advantageously used instead of phenol or salicylic acid. Naphthol is pronounced still preferable. He proposes the law that the physiological action of organic substances is inversely as their molecular weight, and directly as their specific heat. This is precisely the opposite behaviour to that of the metals, according to the law of Rabuteau.

No. 14, 1882.

Action of Aluminium upon Copper Chloride.—Dr. D. Tommasi.—Even at common temperatures aluminium reacts briskly upon a solution of copper chloride. The products of the reaction are hydrogen, metallic copper, and an aluminium oxy-chloride, the composition of which varies according to the degree of concentration of the copper solution. The oxy-chlorides seem not to be definite compounds, but mixtures in variable proportions of aluminium chloride and oxy-chloride. They are non-crystalline, and are easily decomposed if heated even in the water-bath. The solution of aluminium oxy-chloride, like that of ferric oxy-chloride, is precipitated on the addition of sulphuric acid and of certain salts. A single drop of sulphuric acid determines a coagulum of aluminic hydrate so abundant that the whole liquid is solidified. The hydrate obtained is sparingly soluble in sulphuric acid, and is probably not ordinary alumina, but an isomeric modification. Among the salts which throw down alumina from its oxy-chloride are sodium, ammonium, potassium, zinc, copper, magnesium, and iron sulphates. On the contrary, potassium, ammonium, copper, and barium chlorides, potassium bromide and iodide, ammonium and potassium nitrate, do not precipitate aluminium oxy-chloride, even at a boil.

MISCELLANEOUS.

Dephosphorisation of Iron.—At a recent meeting of the Society of Arts a paper was read, by Sid Gilchrist Thomas and Percy C. Gilchrist, on the manufacture of steel and ingot iron from phosphoric pig-iron. The authors, after stating that nearly nine-tenths of the iron ores of Europe were so phosphoric as to produce a pig-iron unfit for steel making without a process of dephosphorisation, showed that by the new lime process perfect dephosphorisation was produced, so that the steel made from phosphoric pig was actually purer than that made from hematite iron. They then instituted a comparison between the basic Bessemer process and the puddling process, pointing out that the former process was peculiarly adapted to the manufacture of soft, weldable steel, having all the characteristics of puddled iron, with considerably greater strength, elasticity, and ductility. It was stated that this soft, basic, Bessemer steel could be made for some shillings a ton less than ordinary puddled iron, while an economy of seven shillings a ton was gained in its subsequent treatment by the smaller loss which it undergoes in rolling. The authors stated that nearly half a million tons a year of the new dephosphorised metal were now being made, and that on the Continent works were erecting having a capacity of a further half million tons a year, while in England the new special works erecting had only a capacity of under 200,000 tons a year. The paper concluded by querying the wisdom of allowing continental ironmasters to push so far ahead of us in the production of this new ingot iron, which was not only cheaper, but immensely superior to puddled iron.

Test for the Purity of Magnesium Phosphate.—Prof. B. Tollens.—If a precipitate of ammonium-magnesium phosphate is contaminated with magnesium or calcium triphosphate, caustic lime, or magnesia, or the citrates of these bases, there is obtained on ignition a white mass, which, if covered with silver nitrate and heated quickly, turns yellow. This test should be especially applied when citric solutions of phosphates are directly precipitated with magnesia mixture.—*Journal für Landwirtschaft.*

NOTES AND QUERIES.

*. Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Chl. rate of Lime.—Will any of your correspondents kindly give me a cheap process for making chlorate of lime? A method by chlorine gas preferred.—J.L.

MEETINGS FOR THE WEEK.

MONDAY, May 15th.—Society of Arts, 8. "Book Illustration: Old and New" (Cantor Lectures), by J. Comyns Carr.

TUESDAY, 16th.—Institute of Civil Engineers, 8.
Pathological, 8.30.
Royal Institution, 3. "Digestion," by Professor A. Gamgee.

WEDNESDAY, 17th.—Society of Arts, 8. "The Constant Supply and Waste of Water," by G. F. Deacon, M.I.C.E.
Meteorological, 7.
Pharmaceutical, 11. (Anniversary)

THURSDAY, 18th.—Royal Institution, 3. "The Metals," by Prof. Dewar.
Philosophical Club, 6.30.
Chemical, 8.

FRIDAY, 19th.—Royal Institution, 8. "The Making and Working of a Channel Tunnel," Sir F. Bramwell, at 9.

SATURDAY, 20th.—Royal Institution, 3. "Poetry and its Literary Forms," Professor D. Masson.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Incorporated 2nd October, 1877.

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SOME OF THE DANGEROUS PROPERTIES
OF DUSTS.

By F. A. ABEL, C.B., F.R.S.,
President of the Institute of Chemistry.

(Continued from p. 202.)

NUMEROUS experiments similar to those of Marreco and Morison were made by the lecturer at Wigan with mixtures of air and coal-dust from Seaham and other collieries, in the complete absence of fire-damp, which were passed through the apparatus at different velocities up to 1000 feet per minute. Small cannon, especially constructed to ensure uniformity in the volume of flame produced at different times, were fired in them, either singly or in pairs in rapid succession; and exposed heaps of gun-cotton and of slow and quick-burning gunpowder were exploded in the dust-laden air. The results occasionally confirmed to some extent those of Marreco and Morison and the Chesterfield experiments. At velocities of 400 feet per minute the dust, which was either passing at the time or was raised by the concussion of a first shot, did not appear to produce any increase in the volume of flame furnished by the cannon, but a decided though inconsiderable lengthening of the flame was several times observed at higher velocities and with the employment of the most inflammable dusts. Some of these, when thickly suspended in air travelling at velocities of 500 to 1000 feet per minute, and exposed to the action of a large flash of flame (as produced by the loose heaps of gun-cotton and blasting powder), exhibited a tendency not only to burn explosively in and close around the flame, but also to propagate flame, or cause it to travel along some distance; but the most decisive results of these experiments were not of a nature to warrant the conclusion that flame could be carried along indefinitely, or even to a very considerable distance, by coal-dust in the complete absence of fire-damp, as now maintained by Mr. Galloway. There can be no question that the scale of magnitude upon which the first ignition in the dust-laden atmosphere is produced must greatly influence the extent to which the propagation of flame in this way will extend, and Mr. Galloway's experiments at Llwynpia, therefore, were likely to develop conditions more nearly approaching those of the real state of things in a mine than experiments in galleries of smaller dimensions, and with small initiating volumes of flame. But the necessity for caution in deducing very decided conclusions from even large-scale experiments appears to be illustrated by some of Mr. Galloway's results, inasmuch as some of the great distances to which the flame extended were observed under conditions decidedly favourable to the projection of the flame by causes which would not come into play in the same way in a mine-working. The experiments made some years ago by Mr. Hall in an adit (which have already been referred to) appear to have a more direct bearing upon results likely to be actually produced underground in a dust-laden atmosphere. In those experiments, the extreme distance to which flame was carried by dust, first ignited by the flame from a very excessive charge of powder (4 lbs.) was 180 feet. It is of course possible that the coal used was not of the most inflammable description, and that its fineness and density were not most favourable to its becoming very thickly suspended in air. On the other hand, Mr. Hall stated, in his

evidence before the Royal Commission that the atmosphere in the adit was only "practically" free from gas.

The volume of flame from a blown-out shot in a mine-working is generally considerable, but it appears that exaggerated estimates are entertained of the distance to which, in the absence of dust, the flame will be projected, and it is probable that the large volumes of flame, extending occasionally to many yards from the spot where the shot was fired, are in a great measure due to the ignition of dust raised by the concussion and rush of air at the instant of firing. Mr. Hall, in his experiments in the adit, found that the flame from the shot of 4 lbs. of powder reached to a distance of only 18 to 21 feet when no dust was present. A few months ago that official directed the attention of the lecturer to the occurrence of two accidents in the Liverpool district, each one occasioned by a shot of 1 lb. of powder blowing out its stemming without shaking or bringing down any coal. In both instances the shot lighter and two pitmen had retired about 100 feet from the seat of the shot, that is, about 30 feet in a straight line with it, and 60 to 80 feet along both directions of a working running at right angles to the drift in the face of which the charge was fired. In the case of one accident, a man was killed, and serious injuries were sustained by the other men in both instances. There were signs of charring upon the props up to, and 5 or 6 feet beyond, where the men were standing; but they did not extend farther. The drift and the level in which these accidents occurred were 5 feet high and 12 feet wide. Mr. Hall informed the lecturer that a strong impression existed among mining men on the spot that the flame of the shot, quite unaided by gas or coal-dust (the latter was known to be present) would have extended so as to produce the effects described. This appeared so at variance with Mr. Hall's experiments in an under-ground working, and with Mr. Abel's own experience in other directions, that the latter has endeavoured to obtain some precise experimental data with regard to the distance to which any burning effect from a blown-out charge of 1 lb. or 1½ lbs. of powder would extend in a mine-working, in the absence of dust. With this object he availed himself of the friendly assistance of Major Durnford, R.E., Instructor in Field Fortifications at the School of Military Engineering, Chatham, under whose direction Lieutenant Raban has carried out an instructive series of experiments in accordance with suggestions made by Mr. Abel as the work proceeded.

The locality selected for the first experiments formed a portion of some obsolete fortifications at Chatham, and consisted of a masonry gallery or *Caponier*, 8 feet 8 inches high to the spring of the arch, and 8 feet wide below the arch, to a distance of 28 feet from the closed end; from that point it tapered on one side to 6 feet along a length of 2 feet 6 inches, and was 6 feet wide for a length of 3 feet 6 inches, up to a pier or square column 4 feet by 3 feet 6 inches; round which the gallery curved, being at this part 4 feet 2 inches wide. The straight part of the gallery, from the dead wall at one end to the projecting pier at the other, was 34 feet long. In the wall to the left of the blocked end there were six narrow loop-holes up to the curve, commencing at 18 feet from the end, and 2 feet 6 inches apart; in the opposite wall there were four, commencing at the same distance and 5 feet apart. Over the wall at the blocked end of the gallery there was an opening into the outer air, and a considerable current of air passed through it along the gallery to the curved end, which led into a large narrow gallery at right angles to this wide one, and having large chambers opening into it.

In some preliminary experiments, an iron tube was let into the face of the wall at the blocked end of the gallery, so as to represent a strong blast-hole, and this was charged with 1½ lbs. of powder, untamped in some experiments and tamped in others; some pieces of gun-cotton were suspended from the roof of the gallery, at a distance of 28 feet and farther along, and observers were stationed outside the gallery opposite the several loop-holes. But, while the pieces of gun-cotton were not inflamed, there were confli-

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 28, 1882.

ing opinions concerning the distances at which flame was seen, probably caused by the general illumination of the gallery by the flash of the explosion. It was, moreover, found that the iron tubes containing the charges were more or less considerably torn, so that portions of the exploding charge escaped laterally. The following method of experimenting was eventually adopted. Charges of $1\frac{1}{4}$ lbs. and 2 lbs. of powder, untamped and tamped, were fired from a small roughly bored out gun-block, the bore of which was 1 foot 9 inches long and 2½ inches in diameter: the gun was raised so as to project the flame right along the gallery at about its centre. A light woodwork frame, 5 feet square, was fitted with thirty-six cross wires 1 foot apart, so as to furnish thirty-six points of intersection; to each of these points a small tuft of gun-cotton was attached, and the target thus fitted was fixed vertically so as to face the charge, in the centre of which was fixed an electric fuze. In this way small charges of gun-cotton were distributed uniformly over all parts of the target, which filled a great part of the section of the gallery. The distance of the target from the charge being gradually increased in successive experiments to 20 feet, it was found that with the employment of $1\frac{1}{4}$ lb. and 2 lb. charges, untamped, in three instances out of ten experiments only one, or at most two, of the tufts of gun-cotton were inflamed, this being apparently the extreme distance to which flame, or matter sufficiently hot to inflame gun-cotton, was projected. At a distance of 10 feet, with $1\frac{1}{4}$ lb. charges, two out of three shots did not inflame any of the gun-cotton tufts. With $1\frac{1}{4}$ lb. charges firmly tamped, one tuft only of the thirty-six was fired, in two experiments, at a distance of 20 feet, while in three others no gun-cotton was inflamed.

It appears from these results that in a gallery or mine-working of an area not very dissimilar to that in which the accidents just referred to occurred, the flame or heated gases from $1\frac{1}{4}$ lb. and 2 lb. charges, fired under conditions favourable to the production of the maximum flame, and its complete projection in the direction of the discharge, only reaches occasionally, and to a very limited extent, to a distance of 20 feet. No doubt a powerful air current in a mine, passing in the direction in which the shot is fired, must have a tendency to aid the spread of the flame to a greater distance, but the difference between 20 feet and 100 feet, the flame having in the latter instance extended to a distance of 75 feet along a gallery at right angles to the point of ignition, is far too great to be only ascribable to the effect of an air current in elongating the flame. As the first of the loopholes above referred to existing in the walls of the gallery was 18 feet from the shot, they could hardly affect the distance to which the flame was found to reach.* It will be observed that these results correspond with those which Mr. Hall obtained with 4 lb. charges of powder in an adit, the dimensions of which are not specified.

No gallery of large dimensions and free from the small lateral openings was available for the continuance of these experiments, but it was thought that some experiments in subterranean passages of much smaller dimensions (military countermines) might give instructive results. A so-called envelope gallery was therefore first selected for the purpose. This gallery was 5 feet 9 inches high to the crown of the arch, and 4 feet 9 inches to the springing of the arch, and only 2 feet wide. The part selected for the position of the gun and the target was straight, but the portion immediately beyond was curved. In rear of the gun, the gallery was quite open to a considerable distance. One-and-a-half pound charges, untamped, were fired, and a frame-target the width of the gallery and 4 feet 6 inches high, constructed so as to give 15 points for the attachment of gun-cotton tufts, was placed at gradually decreasing distances from the gun, commencing at 20 feet. Even at a distance of only 14 feet from the charge none of the gun-cotton tufts were inflamed; but the target was blown forward about 12 feet and partly broken. It was evident that the fact of the gallery being open at the rear of the

charge greatly reduced the tendency to the projection of flame to a distance in the direction of the explosion. The resistance opposed to the movement of the air by the curvature of this very narrow gallery, a short distance in front of the seat of the experiments, may have also contributed to diminish the distance to which the flame or highly heated gases would extend. When the experiments were continued in another gallery, of the same dimensions but straight and terminating in a head, like a drift in a mine, the cannon being placed close up to the face of the drift, several of the tufts of gun-cotton were inflamed at a distance of 27 feet; one was inflamed when the target was 30 feet off, and one also at a distance of 32 feet, but none were ignited at a distance of 35 feet from the charges. Here, then, in a long gallery, narrow in proportion to its height, but in all respects representing a drift way in a mine, the distance to which the flame of a blown-out shot of $1\frac{1}{4}$ lbs. of powder extended was less than 35 feet, and therefore considerably less than one-half the distance from the seat of the blown-out shot of 1 lb. of powder where the men were burned, in both directions in the cross workings, in the accident above cited. The influence of coal-dust in increasing the distance to which the flame from a blown-out shot will extend in mine workings is therefore conclusively demonstrated by a comparison of the effects of those accidents with the foregoing experimental data. On the other hand, the important circumstance noticed by Mr. Hall that no signs of burning on the props in the mine were visible at greater distances than a yard or two beyond the spots where the men were waiting, although there were open workings in both directions for some considerable distance, and although the flame was sufficiently extensive at those spots to injure the men severely, proved conclusively that coal-dust had not the power, in these two instances, to carry on the flame to a great distance from the source of fire. Had there been any gas in the air of the mine the flame would doubtless have extended much farther, and perhaps throughout the adjacent workings. The amount of dust raised by the blown-out shots may, however, have been less considerable than in other similar occurrences, and the dust itself may not have been so highly inflammable, or otherwise of so suitable a character for carrying on flame, as that existing in other mines where undoubtedly dust has played an important part in enhancing the magnitude of explosions. At any rate these results demonstrate the necessity for the exercise of caution in drawing conclusions of too sweeping a nature with regard to the causes and the extent of such coal-mine explosions as cannot be quite clearly ascribed to fire-damp. A few experiments have been made, in the largest gallery (Caponier) at Chatham, to test the power of coal-dust to carry on the flame from a blown-out shot. A large quantity of very fine and inflammable coal-dust from Seaham Collieries was suspended in the air by employment of sufficient mechanical contrivances, and clouds of the same dust were also blown into the gallery in the direction of the shot, and immediately in front of it, just when it was fired. One of the flame-screens was placed across the gallery where the pierjuttet out (at a distance of 34 feet from the shot), and pieces of gun-cotton were attached to nails driven in the wall along the short narrow part of the straight gallery and to some distance round the curve. In every one of the experiments tried (three) with $1\frac{1}{4}$ lbs. of powder, fired when dust was thickly suspended and carried along in the air, the flame burned a number of pieces of gun-cotton on the screen; in two experiments gun-cotton was burned at a further distance of 1 ft. 6 ins., but not beyond; in the third, some flame travelled to the end of the straight gallery, and to a distance of 4 ft. 8 ins. beyond the curve, but gun-cotton was not inflamed beyond that point. In this case, therefore, flame reached rather more than, and in the others not quite, double the distance with dust thickly suspended in the air, to what it did in the absence of dust. Experiments will be continued in the long narrow galleries which have been spoken of.

* The closing up of these was not found to affect the results.

It must now be accepted as beyond question that very few, if any, explosions have occurred of which the destructive effects, so far as burning and production of the fatal after-damp are concerned, have not been more or less considerably increased through the agency of the coal-dust raised by the explosion, and that the latter has been in very many cases instrumental in causing the burning effects of the explosion to spread over great areas, and to reach to workings which, in the absence of dust, would have escaped the visitation. Even of late years, long since the observations of Faraday and Lyell have been confirmed and extended, mining engineers and others immediately connected with the working of coal-mines have been very prone to ascribe explosions, which did not admit of satisfactory explanation by an accidental failure of ventilation or other evident causes, to the sudden disengagement or outbursts of fire-damp, such as are, in fiery coal seams, of no uncommon occurrence, and sometimes very serious in their magnitude and long continuance, and and to charge such sudden escapes of gas into some part of the mine-workings with the whole extent of the disaster, rather than to credit coal-dust with any important share in the origination or even in the extension of the explosion. In many instances the occurrence of such outbursts, following upon falls of roofs or the firing of shots, or the rapid disengagement of fire-damp from coal or goaves, consequent upon sudden changes in atmospheric pressure, have been clearly proved to have preceded disastrous explosions. In others, however, the conclusion that an explosion has been connected with the occurrence of a sudden disengagement of gas in considerable volume has been based upon assumptions or conjectures, more or less admissible, or upon evidence of doubtful nature collected after the explosion (as in the case of the recent explosion at Seaham Collieries). Under any such circumstance, however, it is, to say the least, extremely difficult to realise how sufficient gas to produce an explosive atmosphere can be conveyed, even by the most powerful ventilating currents which can circulate in mines, from the seat of such a sudden outburst to far distant portions of the mine to which the actual explosion is proved to have extended, within the period which is known, or believed, to have intervened between the first disengagement of the gas and the firing of the explosive atmosphere produced thereby in the vicinity of the outburst, by the firing of a shot, by a defective lamp, or by other means of ignition. On the other hand, the character of the effects which in many instances have been produced by the explosion; the evidences of severe burning such as could not be produced by the rapid explosion of a gas-mixture only, and the deposition of partially burned or coked dust in very distant and distinct parts of the mine workings, leave no room for doubt that coal-dust has played a more or less important part in almost all the explosions which have been of late submitted to investigation. Further, it must be conceded that in some instances coal-dust would indeed appear to have been the chief instrument of destruction.

(To be continued.)

ACTION OF CHARCOAL UPON A SOLUTION OF GOLD CHLORIDE.*

By Prof. GEORGE A. KOENIG.

AMONG the substances which decompose gold solutions, the text-books—and, as far as I could find, the special literature—do not mention charcoal. This property of charcoal has become the subject of a United States patent, claiming that by filtering liquids containing in solution gold and certain metallic salts, the gold alone would be precipitated upon the charcoal, and none of the other metals. In the spring of 1880 my attention was drawn to

this subject, and, as the fact appeared unquestionable, it became of some interest to ascertain the reactions involved.

The following possibilities suggested themselves:—

1. Gold might be precipitated by the alkaline carbonates of the ash mixed with the charcoal from the charring process.

2. Gases condensed in the coal might act as reducing agents.

3. The action might be physical only, belonging to the so-called catalytic phenomena.

4. Carbon might be oxidised by auric chloride and water, either to carbon monoxide or dioxide.

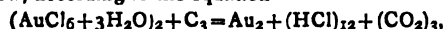
Gold hexachloride was prepared as nearly free from uncombined chlorine as several evaporations to dryness could make it.

Charcoal was broken into pieces, and, by sifting, assorted to an average diameter of about $\frac{1}{8}$ of an inch. It was then digested with hydrochloric and hydrofluoric acids for twelve hours, and washed first with dilute acid, then with distilled water until the latter ceased to act upon blue litmus. After drying, the charcoal was kept at a full red heat for one hour in a closed crucible. Any action produced by this purified material upon gold solution could not be ascribed to inorganic constituents.

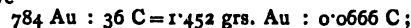
First Experiment.—30 grms. of the charcoal were placed into a half-litre flask, and the latter filled one-half with water. Heat being now applied, the contents of the flask were kept boiling for thirty minutes, under replacement of the evaporating water. Condensed or occluded gases were now presumably expelled, and a measured aqueous solution of gold chloride, corresponding to 1.452 grms. of metallic gold, was added, whilst the flask was furnished with a doubly perforated cork, and left at ordinary temperature for two hours, when the yellow colour of the liquid had disappeared and the charcoal become coated with gold. Having now connected the flask on one side with a Geissler potash bulb, filled with aqueous barium hydrate, and on the other with a gasometer, containing pure air, the flask was again brought to boiling, while a slow current of air passed into the flask, the air passing through several U-tubes containing sodium hydrate. A turbidity in the barium hydrate became visible at once, and after fifteen minutes of boiling the precipitate of barium carbonate was determined as barium sulphate with the usual precautions.



Now, according to the equation—



we have—



that is to say, that only about one-twentieth of the gold was precipitated by the chemical action of charcoal.

A closer examination of the charcoal showed a marked difference. Some pieces had a brilliant compact coating of gold, others a dull porous coating, and many none at all.

Second Experiment.—Lampblack was strongly heated in a closed crucible to redness. It was then washed with hot water and again dried. If the action of the charcoal were chemical, then lampblack should act more readily. In order to test this assumption 0.2 grm. of gold, as chloride, was dissolved in 100 c.c. of water and 6 m.grs. of the above lampblack added. A disengagement of gas was noticed at the boiling heat, and also a slight precipitation of gold. Boiling was kept up for two hours, when the liquid was still coloured from gold chloride. Again 6 m.grms. of lampblack were added and boiled for three hours longer with a condenser attached. The liquid was now filtered and still yellow in colour, while the precipitated gold was largely mixed with lampblack. After ignition the gold weighed 0.0495 grm., or nearly one-fifth of the quantity contained in the liquid.

These experiments do not cover the entire field of inquiry upon the subject, but they seem to indicate a parallel physical and chemical action, the former depending upon

* From the *Journal of the Franklin Institute*, May, 1882.

the surface and capillary condition of the charcoal, lamp-black not acting physically at all, the latter depending upon a combustion of carbon into carbon dioxide.

University of Pennsylvania, March, 1882.

ON TWO JAPANESE METEORITES.*

By EDWARD DIVERS, M.D.

THESE meteorites are the property of a gentleman, Mr. Naotora Nabeshima, formerly Daimiyo of Ogi or Koshiro, in the province of Hizen, Japan. They are heirlooms in his family, and used to be in the care of the priests of one of the family temples in Ogi, called Fukuchi-in Gomado. After the revolution, the temple was closed, and the meteorites restored to the keeping of their present possessor.

In the family archives there is a record of these stones having been entrusted some years after their fall to a priest named Jishobo, which is dated the 7th day of 11th month of the 1st year of Yenkiō (Dec. 10, 1744); Jishobo's receipt for them is also preserved. They must therefore have fallen about 150 years ago. They used formerly to be among the offerings annually made in the temple in Ogi to Shokujo (Tanabatatsume) on her festival, the 7th day of the 7th month. There is no mention of them having fallen on this day in the year, but they were connected with her worship by the belief that they had fallen from the shores of the Silver River, Heavenly River, or Milky Way, after they had been used by her as weights with which to steady her loom.

For the above particulars I am indebted to my friend and former pupil, Mr. Nakano, now one of the instructors in Kobudaigakko (Imperial College of Engineering, Tokiyo).

The meteorites are somewhat similar in appearance, being angular masses, evidently fragments, irregular quadratic pyramids in shape. The apex of the pyramid in the larger stone is obliquely truncated, as is also one of the basal angles of the smaller one. In the smaller one, the region of the rounded off apex shows a number of small pits or depressions. Faintly marked, thin ridges and streaks, are to be seen on both stones, radiating with some regularity from about the centre of the base over the basal edges towards the apex. The edges and faces are all rounded off, and have a very thin, nearly black, coating, such as is generally found on meteorites. This coating in the larger stone is entire, except at one corner, where it is slightly broken away. The smaller one has its surface more damaged, and has therefore been used for the chemical analysis. The interior of the stone is light grey in colour, earthy, porous, somewhat soft, and interspersed with particles of metallic iron, and a few of iron sulphide. No other minerals have been clearly made out.

The black coating, which is hard and somewhat shining, is readily attacked by hydrochloric acid, very slightly effervescing with a weak smell of hydrogen sulphide, and seems to be formed of iron, partly oxidised and sulphurised. It is just such a metallic facing as might be caused by the friction of cosmic dust, probably of like composition to the meteorites. This friction, which may have been going on for a long period during the flight of the stones through space, would also have produced that rounding off of their edges and faces which is so marked.

The larger meteorite weighs 5.6 kilograms, and the smaller at first weighed about 4.6 kilograms. Their sp. gr. is 3.62, as determined in a fragment of the smaller one, without, however, any special precautions having been taken to displace all air in its pores.

The chemical composition of the smaller of the meteorites has, by my direction, been determined with much

care and skill by Mr. Shimidzu, one of the students of the Kobu dai Gakko, at present educating as a chemist.

PERCENTAGE COMPOSITION.

Elementary.

Oxygen	33.18
Iron	26.13
Silicon	17.15
Magnesium	14.02
Sulphur	2.15
Nickel with trace of cobalt ..	1.99
Calcium	1.39
Aluminium	1.00
Sodium	0.72
Manganese	0.57
Tin, with trace of copper ..	0.15
Phosphorus	0.15
Potassium	0.13

99.01

With the Oxygen Distributed.

Iron	15.35
Nickel, &c.	1.75
Manganese	0.18
Tin, &c.	0.15
Iron mono-sulphide	5.91
Iron chromite	0.61
Phosphoric oxide	0.34
Silica	36.75
Magnesia	23.36
Iron monoxide, as silicate ..	8.64
Lime	1.94
Alumina	1.89
Sodium oxide	0.97
Potassium oxide	0.16
Manganese monoxide	0.51
Nickel oxide	0.30

99.01

Mineralogically arranged.

Nickel iron	17.43	} Cont. silica 13.10 = 39.83 per cent of the silicate.
Iron sulphide	5.91	
Silicate, sol. in hydrochloric acid, Olivin	32.89	} Cont. silica 24.30 = 56.30 per cent of the silicate.
Silicates, insoluble in acid	43.16	
Iron chromite	0.61	
100.00		

These meteorites belong, therefore, to that large class which are formed of particles of iron disseminated through a granular earthy mass, and which contain about three-tenths of their weight of iron in the free and combined states. Prof. Nordenskiöld has shown (*Jahrbuch f. Min.*, 1879, p. 77) that if the quantities of oxygen present are neglected, many members of this class exhibit even the same proportions between their elements. On re-calculating the composition of the Hizen meteorites in accordance with this plan, it is found to be practically identical with that of the cementing substance (I.) of the Orvinio meteorites, which fell near Rome on August 31, 1872; and to differ but little from the granular matter (II.) of the same meteorites, as well as from other meteorites. Among these is one which fell in this country in Tajima, on February 18, 1880, and of which an analysis by Dr. Korschelt is to be found in a recent number of the *Transactions of the German Asiatic Society, Tokiyo* (*Mitt. der d. Ges. f. Natur und Völkerkunde Ostasiens*, iii., 204). The calculated numbers are contained in the following table:—

* A Paper read before the Asiatic Society of Japan, Tokiyo, Feb. 9, 1882. Communicated by the Author.

	Hizen.	Orvinio. I.	II.	Tajima.
Iron	39'70			43'65
Manganese	0'86			—
Tin	0'22			—
Sulphur	3'27	44'7	43'29	42'55
Phosphorus	0'22			1'10
Chromium	0'43			0'30
Silicon	26'06	26'09	26'65	2'25
Magnesium	21'30	21'28	20'18	24'47
Nickel and cobalt..	3'02	3'16	4'71	19'56
Calcium	2'11	2'46	2'56	3'86
Aluminium	1'53	1'75	1'91	2'80
Sodium	1'09	1'59	1'10	1'37
Potassium	0'19	0'38	0'34	1'37
	100'00	100'00	100'00	100'00

The interesting fact is thus seen that meteorites which fell in this country one hundred and fifty years ago have the same composition as some of those which have fallen recently, both here and on the other side of the world.

Notes on the Analysis.—Some of the particles of the iron were somewhat rusted from age. If allowance could have been made for this absorption of oxygen and water from the atmosphere, the difference of the total found from one hundred would be less than it is. The portion used for the determination of the silica in the parts soluble and insoluble in acid was small, and was taken separately from the portion, very much larger, used for the main analysis. It is therefore not surprising, when the structure of such a meteorite is considered, to find the sum of the two quantities of silica about half a per cent greater than the total determined in the main quantity. The metallic part of the meteorite was separated from the earthy part by mercury chloride solution. The portions for analysis were removed from the meteorite by a steel drill at a part where the coating had been broken away, in order to damage the meteorite as little as possible. The drill was examined before and after use under a magnifier to obtain the assurance that it did not sensibly contribute its own substance to the dust obtained. A small fragment was rubbed down by a practised worker to serve for microscopic examination, but the earthy matter was too soft to resist the tearing strain of the tenacious iron particles.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING APRIL 30TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington; and late Deputy Medical Officer of Health for the City of London.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

May 4th, 1882.

SIR,—In the following tables you will find recorded the results of our analyses of the 154 samples of water collected by us during the month of April, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 154 samples, seven were recorded as "very slightly turbid." The remaining 147 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from April 1st to April 29th inclusive. The purity of the water in respect of

organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 22 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the East London Company, the whole, excepting three which were "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the West Middlesex Company the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 22 samples from the mains of the Grand Junction Company, four were found "very slightly turbid." The remaining 18 samples were well filtered, clear, and bright.

Of the 22 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be seen from the tables that, during the month of April, the condition of the water supplied to the Metropolis, in respect to clearness and to freedom from brown colour and excess of organic matter, was on the whole considerably in advance even of its condition during the preceding month, despite a few exceptional cases of higher colour and slight turbidity occurring during the last week, and depending on the flooded state of the river.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

PROCEEDINGS OF SOCIETIES.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, March 23, 1882.

Mr. JOHN GLOVER, Vice-President, in the Chair.

THE minutes of last meeting were read and confirmed.

Mr. Gibb and Dr. H. S. Pattinson were elected as scrutineers of the voting papers.

THE CHAIRMAN—Our first business to-night is in connection with Mr. Scholefield's gift. The Committee have had the matter under their consideration to-night, and they have resolved to recommend to the general meeting that it be left in the hands of the new Committee about to be elected, and that they be desired to go fully into the details and arrangements for the appropriation and award of the prize at a special meeting, to be held as early as possible, so that the result of their labours may be made known before the next session.

Mr. BERKLEY moved that the recommendation of the Committee be adopted.

Mr. STARK seconded the motion, which was carried after some discussion.

THE CHAIRMAN—The next item is one which will excite the sympathy of every one. It is that we should formally record the esteem in which we held the late Professor

Marreco, whose death since our last meeting has deprived the Society of one of its most active members. I have, therefore, to move the following resolution:—"That this Society has learnt with deep regret the death of Professor Freire-Marreco, who initiated the movement which led to the formation of the Society, who filled for many years the offices of Secretary and Editor of the *Transactions*, and who for two years occupied the position of President. The Society wishes to place on record its esteem for Professor Marreco personally, and its sense of the valuable services which he has rendered to it from its foundation up to the time of his death."

The resolution was carried unanimously, and the Secretary was desired to forward a copy of it to the family of Prof. Marreco, with an expression of sympathy and condolence from the Society.

The CHAIRMAN—We have next to take the discussion on Mr. Pattinson's paper. It is matter for regret that Mr. Pattinson is not here himself; but Mr. Kay is present, and will be able to reply to any questions which may be put to him on the subject.

Mr. GIBB—I was a good deal interested in the paper. It is a subject which seems principally to have interested metallurgists, and which analytical chemists have done very little in. Abel and Field's method was very disappointing, and was soon thrown over for one of the methods which are now in use in metallurgical laboratories. Mr. Pattinson's method must be very clumsy where the copper is at all coarse and contains much impurity. The process of distilling off the arsenic as chloride is much simpler, and is applicable to precipitates and coarse coppers as well as to purer metal. It has the advantage of separating the arsenic completely from the other impurities. The copper is simply boiled with ferric chloride, and the distillate collected; from this the arsenic is precipitated either as sulphide or as magnesia salt. Another process, which is frequently used, and which is very convenient when the copper contains iron, consists in dissolving in nitric acid, supersaturating with ammonia, and passing sulphuretted hydrogen. In this way practically the whole of the arsenic remains in solution, and can be thrown down as sulphide from the filtrate by acidifying. About twelve years ago I had a series of comparative analyses made by the processes which were then known to us. Abel and Field's method gave us 91 per cent, direct precipitation from fine copper by magnesia 93 per cent. and the ammonium sulphide method 96 per cent.

Mr. GREEN—The ammonium sulphide method was given up in the case of precipitates, because the magnesia present in the common salt used took down a quantity of the arsenic when the solution was made alkaline with ammonia.

Mr. KAY—No doubt Mr. Pattinson's process is adapted to coppers which contain no large quantity of impurity, and with such metals the method is as quick as the distillation process. The distillation process would be objectionable in an ordinary laboratory. The process, as described by Mr. Pattinson, can be carried out very quickly in the hands of one accustomed to the method. The whole estimation need not take more than one day.

Mr. GREEN—The distillation takes about twenty minutes, and the whole estimation can be done in three hours. We estimate our arsenic volumetrically, however.

Mr. KAY—Mr. Pattinson's process is exceedingly delicate. We can detect and estimate by it 0.01 per cent. Such accuracy may not perhaps matter when the copper contains much impurity, but in copper which is nearly pure it becomes of importance; and we find that, under proper conditions, there is no necessity to let the magnesia precipitate stand, but that the filtration may be proceeded with immediately.

Mr. GIBB—It is quite contrary to our experience that there is any safety in filtering at once.

Mr. KAY—I know that is the general impression of chemists, but it is quite a mistake if proper precautions are taken.

The CHAIRMAN—We are indebted to these gentlemen for the information they have given us. It is a subject to which I cannot offer any valuable contribution; but one thing seems clear, that is, that quantities of impurities in commercial metals, which, a few years ago, would have been considered so small that they could safely be neglected, are now no longer so; but their determination has become a question of importance, and our analytical methods have to be improved to meet the want.

The following papers were read:—

"A Lecture Experiment," by WM. JOHN GREY.—Mr. T. Liddle, a student of mine, noticed on passing SH_2 through a warm HCl solution of a substance given him for analysis that the gas took fire in the liquid. I found that the substance contained KClO_3 , and repeated the experiment with a warm HCl solution of that salt. Doubtless the SH_2 inflames in the O_4Cl_2 dissolved by the liquid. The experiment would be a striking one for lecture purposes.

"On the Solubility of Sulphur Dioxide in Sulphuric Acid," by J. T. DUNN, M.Sc.

The Scrutineers then declared that the following had been elected officers for the ensuing year:—

President—B. S. Proctor.

Treasurer—John Pattinson.

Secretaries—J. T. Dunn, W. W. Proctor.

Auditor—N. H. Martin.

Committee—P. A. Berkley, G. France, A. S. Herschel, C. P. Laidler, John Morrison, H. R. Proctor, W. C. Reid, W. Rennoldson, H. Scholefield, T. W. Stuart.

Votes of thanks to the authors of papers terminated the proceedings.

NOTICES OF BOOKS.

Rivers' Pollution Prevention Act, 1876. Report to the Local Government Board. By Dr. R. ANGUS SMITH, F.R.S., One of the Inspectors under the Act. London: Printed by G. E. Eyre and W. Spottiswoode for Her Majesty's Stationery Office.

We have here a most important contribution both to sanitary and industrial chemistry. The author treats in the first part on water and sewage. He sets out with examining the changes effected by oxygen upon organic matter dissolved or suspended in water, and especially the formation and destruction of nitric acid. Dr. Angus Smith has long ago held that the mere presence of organic matter in water is no proof of unwholesomeness. For this purpose the quality as well as the quantity of such matter must be known. Hence he considers that the development of organisms in water should be studied microscopically. On the question of nitrification he concludes that organic matter containing nitrogen produces nitrates by oxidation under certain conditions, whether living organisms are present or not. Inorganic matter containing ammonia does the same. Albuminous matter, when putrefying with plentiful access of air, also oxidises the organic nitrogen. On the other hand there are putrefactive conditions, where nitrates are deoxidised and free nitrogen evolved in quantity. That this action is due to organisms may be doubted, as it is active at 71°F . In one experiment 1100 c.c. of water containing 10 per cent of excreta and 2 grms. of nitre gave off 218 c.c. of pure nitrogen. The whole amount of nitrogen present in the nitre was 220.6 c.c. The author thinks that this decomposition of nitrates is a reversed putrefaction, and should be carefully noted in considering the action of disinfectants. In summing up the facts he concludes that nitric acid is formed when there is a certain amount of sewage in the water, but it is overcome by an excess of air. On the other hand, when the sewage is in excess, the nitrates are destroyed. If we duly consider this double process we

shall become convinced of the futility of all attempts to estimate the amount of contamination which has existed in water from an analysis of its present ingredients. We see, also, that water, however contaminated, has a power of self-purification, which may extend even to the germs of disease. It is an interesting fact that mere agitation with air keeps sewage without smell for two or more weeks, even in warm weather. We would beg to remind recent inventors that the purification of sewage by a current of air driven through it by mechanical agency, was claimed more than ten years back. The decomposition of sewage appears to differ in its quality from that of excreta not mixed up in water; the latter giving off more ammonia, but the former having a more markedly injurious action. Prof. Frankland, if we remember rightly, contends that the bubbles which rise from polluted waters as they burst project morbid particles into the air. The effects of aeration are the delay of putrefaction, the increase of nitrates, and the withdrawal of ammonia.

As a possible method of purifying sewage, Dr. A. Smith suggests that putrefaction might be first allowed its full action in order to decompose much of the organic matter, and probably to break up the living organisms themselves into gases or intermediate products, and that the process should then be completed by aeration. Oxidation is found to take place very rapidly after putrefaction. But at what stage of putrefaction, if at any, the disease germs are destroyed is not yet known. Beings much higher in the scale, such as trichinæ, seem to be little, if at all, affected when placed in the midst of putrescent animal matter.

The author, however, by no means recommends this process of purification by putrefaction to be carried on in our streams. Whilst admitting that "disease has not to any very marked extent been observed as following the use of sewage irrigation," he considers that there may be danger where the sewage has been transmitted to the soil too rapidly. He adds: "On this point we must refer to the remarkable inquiry by Dr. Greenwood. At a mill near Bingley, wool sorter's disease and malignant pustules had broken out among those who worked with mohair coming from Van. To disinfect the wool it was exposed to the air on a field. In a few days a cow died in a field which received the village sewage, and next month cattle and sheep were attacked by anthrax."

A striking instance has occurred lately in France. A tripe-dresser in a large way of business had been in the habit of passing all his washing waters and trade offal into a pond on his premises. In course of time the pond was complained of as a nuisance. To get rid of this the owner obtained the consent of a neighbouring farmer for the water and the mud to be conveyed to his fields. The result was a very severe and obstinate outbreak of diphtheria.

Dr. Angus Smith asks: "What advantage would it be to a city to send down its sewage into a river in a condition in which it did not putrefy if it were to have an appearance of impurity as great as ever?" Something more is demanded, and appearance is perhaps the chief point. For, be it observed, "we have not proved any disease to occur from the sewage below Glasgow or Manchester." If this is the case,—and we cannot for a moment question the author's statement—how very trifling becomes the boast of the irrigationists that the vicinity of their farms is not marked by increase of epidemics!

As regards fish, Dr. Angus Smith remarks that sewage is an excellent feeder of fish, though these do not enter the places where sewage is very strong, and never at all where there is putrefaction going on. This is the exact truth. The point where the sewage of Kingston entered the Thames was, about seven years ago, a favourite spot for anglers. On the other hand, we have repeatedly been informed that sewage fish becomes offensive with exceptional speed.

As regards the use of lime for the treatment of polluted waters, the author admits, somewhat drily, "that something more would not be a disadvantage."

Mention is made of the use of alum in India and China for purifying drinking-water by precipitation. It may here be noted that by means of this simple expedient the French troops in Cochin China are now almost completely preserved from the very malignant dysentery there prevalent. The same method has been used by Mr. Peter Spence for removing the yellowish peaty tinge from the Manchester water.

Concerning the waste-waters from dye- and print-works, the author very judiciously recommends that the various kinds of refuse should be allowed to mix together, and to a great extent precipitate each other. Chloride of calcium is recommended as a precipitant where it can be obtained as a waste-product. We see with much interest that Dr. A. Smith recognises a point in the treatment of sewage which certain other authorities on the question have overlooked, and have thus been led astray. He points out that if effluents are agitated with the precipitant the result is to a great extent frustrated. The inefficacy of lime for dealing with certain colouring-matters in waste-waters is fully admitted. This was noted in case of peat-water, where 2 grs. of lime per gallon intensified the colour. Tan liquors also were darkened in colour by the addition of lime. Similar facts have been frequently noticed in the treatment of the Leeds sewage, which contains much water from tan- and dye-works. The yellowish brown liquid was darkened to a rich mahogany shade by treatment with lime, whilst it could be completely decolourised by the addition of cake alum, and still better aluminium chloride.

But we must pass to that very sore subject the reformation of the alkali-waste heaps and their drainage. What a nuisance such heaps are is but too well known at St. Helens, Widnes, Newcastle, and Glasgow. The process of Mr. Mond recovers a large proportion of the sulphur contained in the waste, and leaves, it appears, a certain profit. But, as Mr. Worsley, of Netham, shows, the profit is but small, and the manufacturers naturally prefer to use their capital in other directions.

Another process is in use at Dieuze, in Alsace. It was first suggested by Dr. E. Hofmann, developed by Dr. E. Kopp, and has been further improved by M. Marchal. Dr. Angus Smith gives an extended account of the process as described by Prof. Rosenstiehl, of Mulhouse. It consists of six distinct steps, transformation of the waste into soluble sulphur compounds, or so-called yellow liquors; precipitation of the sulphur by the acid of the chlorine residues, and their subsequent neutralisation; removal of the iron by fractional precipitations; precipitation of manganous sulphide; combustion of this sulphide, and the utilisation of its ash. The principal novelty of the process, which has been at work since 1867, is the incorporation with the tank-waste of a certain amount of the sulphides of iron and manganese. By this means 44 per cent of the total sulphur contained in the waste is extracted in a soluble form within eight days. The process furnishes two useful products: sulphur, either free or combined with manganese; and a regenerated oxide of manganese, fit for yielding chlorine. The solid refuse is a mixture of calcium sulphate and carbonate with insoluble iron and manganese oxides. The liquid portion is calcium chloride.

The Macfear process, devised and successfully carried out at the St. Rollox Works, depends on the decomposition of calcium sulphides by hydrochloric acid in presence of a source of sulphurous acid. The author is of opinion that the application of some form of this process to the waste drainage of St. Helens and Widnes would not merely reduce the nuisance complained of there, but would form a profitable means of utilising the great surplus of hydrochloric acid. This acid can scarcely be advantageously employed in the manufacture of bleaching-powder, as there are already serious complaints of over-production.

Dr. Angus Smith has himself devised a process, which turns on treating the extract of the waste-heaps with

manganese peroxide. The process does not succeed with strong solutions, and the sulphur present in the hypsulphites is not precipitated.

For a description of the process of Messrs. Helbig and Schaffner, we may refer the reader to Professor Lunge's well-known work on "Sulphuric Acid and Alkali." It is being completely tried at the works of Messrs. Chance, near Birmingham, and as far as the production of sulphuretted hydrogen and its combustion are concerned the success is complete. In conclusion, the author strongly urges manufacturers to turn their attention to the recovery of sulphur, not merely as a question of public health, but of economy. Vast quantities of sulphur, now thrown away daily, are capable of being used over again. That a certain outlay is required for this purpose must be admitted. But our present system of allowing the tank-waste to remain literally as waste is not free from expense. In some parts alkali manufacturers are compelled to buy or rent land where this unsightly refuse may be deposited, and have to live in peril of litigation on account of the nuisance which it may occasion. On the Tyne the waste is carried away in specially-constructed steamers and barges and emptied into the sea!

Dr. Angus Smith's work will be most welcome both to sanitary reformers and to chemical manufacturers, and cannot do other than enhance his well-earned reputation.

City and Guilds of London Institute for the Advancement of Technical Education. Report to the Governors, March 13th, 1882. Gresham College.

THIS Report, which was laid before the Governors at their meeting, contains not a few gratifying features. The acceptance of the Presidency of the Institute by H.R.H. the Prince of Wales is a proof that our future sovereign fully appreciates the importance of the movement and recognises its influence upon our national interests. No fewer than eight additional City Companies—viz., the Grocers, Skinners, Vintners, Tallow-chandlers, Plumbers, Wheelwrights, Bowyers, and Curriers—have become contributors to the funds of the Institute. We learn that the Drapers Company have munificently given £20,000 towards the expense of erecting and fitting up the Technical College at Finsbury, which raises their total contribution to £20,000. The Goldsmiths have contributed the like sum; the Clothworkers £19,000, in addition to the important support which they have extended to the Yorkshire College of Science at Leeds. The Fishmongers have contributed £18,000, and the Mercers £8000. Others of the City Companies have also come forward in proportion to their means, and to the extent in which their especial "art or mystery" is likely to be benefitted by the operations of the Institute. A thought here strikes us as regards the future: seeing how largely the efficiency—we might say the very existence—of the Institute depends on donations and annual subscriptions from the Corporation and the Guilds, what would be its position if these bodies should by legislative interference be deprived of the means for continuing their liberality? The Council, as we see from this Report, are appealing to the Corporation and Livery Companies for "increased and additional contributions"; and such contributions are needed if the Institute is to come forward as a successful competitor with the Polytechnic Schools of Aix-la-Chapelle, Zurich, &c. The present income of the Institute shows, indeed, a surplus on the present limited expenditure, but such surplus is likely to be absorbed by provisions for the Building Fund. Parenthetically we would here express the hope that the Institute may guard against an error sometimes perceived in colleges, museums, &c., where efficiency is sacrificed to appearance, and where, in the words of Waterton,—

' The walls are thick, the servants thin
The gods without, the devil within "

The Council are anxious to follow up what they have

begun. They wish to widen the curriculum of Finsbury College, so as to adapt the instruction to industries hitherto left out in the cold. They wish to establish on the south side of the river a Technical College similar to that at Finsbury. They are seeking to found a Technical School for girls, where young women may receive instruction in those trades which appear suitable for female handicraft; and they wish especially to do more than they have hitherto been able towards promoting technical training in the great manufacturing centres of the Provinces. They are continually asked to extend their operations in these directions, and all that is needed is an increase of funds.

We are glad to find that the Council duly recognise the importance of a preliminary training in pure science. Without this basis technology must degenerate into mere routine and rule-of-thumbism. At the same time we venture to express the hope that the opposite error of requiring a knowledge of irrelevant matters will be avoided with an equal care, especially as this is a peculiarly English shortcoming, and has taken deep root, e.g., in the "Science and Art Department." We can scarcely pronounce it judicious to demand a knowledge of botany from students in dyeing and tissue printing.

As regards the instructions given in technical chemistry, we consider the Institute fortunate in having secured the services of so indefatigable and successful a worker as Dr. H. Armstrong, F.R.S.

The number of students who come forward as candidates at the various examinations is increasing, the proportion of those who pass is satisfactory, and many of the examiners report most favourably of the character of the answers given, and of the evident increase of knowledge in comparison with the earlier examinations. The difficulty is how to arrange these examinations so as to fairly test the practical attainments of the students as distinguished from the results of mere verbal memory. It is conceivable that, e.g., a student from a careful study of books might have acquired the power of passing a good examination in dyeing and tissue-printing, and yet be unable to dye a skein to shade, to mix a colour so as to be capable of use, or even to identify a dye-ware. There is considerable difference of opinion whether the theoretical training in the College or Polytechnicum ought to come after or before a practical course in the workshop. Many eminent German authorities maintain that a lad ought to work for two or three years in, e.g., a dye-house before entering upon the study of chemistry and physics and their special application to the tinctorial arts. We should incline to the opposite opinion. In any way theory and practice must be had in combination, and the misfortune is that too many of our industrials, whether employers or employed, are not well versed in either. A German contemporary remarked only a few days ago:—"English industry is so far in the background, both in dyes and in their collocations, that even with the best will the importation of foreign textile goods must continue." And, again:—"English dye-works are on a large scale, but they dye no excellent colours." A lecturer in Manchester represents our dyers and printers as replying to such charges that they could turn out colours equal to any in the world, only that ordinary work pays them better. We reply that all men must sooner or later lose the power of doing what they never practise. Let us hope that in this as in other departments the action of the City and Guilds of London Institute may open the eyes of our practical men to their own shortcomings.

Appointment.—Dr. Meymott Tidy, Professor of Chemistry and of Forensic Medicine at the London Hospital, has been appointed, on the nomination of the President of the Royal College of Surgeons, Scientific Analyst to the Home Office in cases of poisoning, jointly with Dr. Stevenson, of Guy's Hospital, nominated by the President of the College of Physicians.

CORRESPONDENCE.

ON THE EQUIVALENT OF CARBON.

To the Editor of the Chemical News.

SIR,—A note by Professor Roscoe "On the Equivalent of Carbon Determined by Combustion of the Diamond," in the *Comptes Rendus* (No. 17, April 24th, 1882, p. 1180), gives the results of six experiments with Cape diamonds. Taking the combining weight of oxygen as 15.96, that of carbon is given as 11.07. This startling result has also appeared in an English journal.

Feeling sure that 11.07 was a misprint of 11.97, I have just calculated the number from the weights of diamond and carbon dioxide given, and find 11.973.

Hoping that this may prevent diffusion of a startling misprint,—I am, &c.,

W. H. DEERING.

Woolwich Arsenal, May 10, 1882.

VERTICAL VIBRATION.

To the Editor of the Chemical News.

SIR,—Might I draw the attention of some of your readers to this point? I have often noted, with much curiosity, that on striking the edge of a large bowl, full of water, with a heavy instrument, the water has assumed a series of beautiful, corrugated waves, mathematically exact in relation to one another. In a circular vessel, for instance, the first sign is concentric rings from the centre; these rings become striped radially (so to speak), and on hitting harder these break up, and the surface becomes like a star of roof-shaped waves, widening outwards; a still harder and closer blow, and the whole surface appears like rough <-shaped links interfitting with one another, becoming more and more spherically inclined, and so forth. There is a law at work here, for it always gives the same results. We see the ground plan of vibration in plates upon which sand, &c., has been sprinkled before setting them in motion; but with water we have also the vertical section of these motions,—we have pictured before us the force in every direction (as confined by circumstances); certainly an interesting point.—I am, &c.,

D. Y. C.

Leeds.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chimie.
April, 1882.

Action of Iodine upon Methylated Spirit.—M. Ordonneau.—The author shows that tincture of iodine cannot be made with such alcohol, as a pungent irritating compound, acetone mono-iodide, is formed at the expense of the acetone, which is always more or less present in the methylic alcohol employed.

Determination of Sugar with Fehling's Liquid.—E. Boiret.—The author proposes the following method for ascertaining if the reduction of the copper is complete: There are placed upon each other two fragments of white filter paper. Upon the upper fragment there is placed, with the stirring rod, a drop of the boiling mixture of Fehling's liquid and of the saccharine solution, holding cuprous oxide in suspension. The paper acts as a filter, and only the copper in solution, and consequently not

reduced, arrives on the lower paper. Upon the drop thus filtered there is laid a drop of a dilute solution of potassium ferrocyanide, and the paper is dried over a spirit-lamp. If there is an appreciable quantity of copper the spot, on drying, is surrounded with a rose-coloured halo. If there is a mere trace, the characteristic rose tint appears on moistening the spot with a drop of acetic acid. If the copper is entirely reduced, heat and the application of acetic acid produce a blue spot, due to the decomposition of the ferrocyanide.

Colouration of Maccaroni, &c., with Chrysianiline.—M. St. Mercier.—This colour, otherwise known as aniline yellow, is now often substituted for saffron. Dilute sulphuric acid instantly discharges the colour of chrysianiline, but leaves the yellow of saffron unaffected.

American Lard.—Much of this is a mixture of tallow, stearine, oleomargarine, fat of bacon, &c.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., March, 1882.

Electric Transportation of Energy.—Maurice Lévy.—The author concludes that the transportation of a given quantity of energy to any distance whatever, with a given yield, finds no solution in the laws hitherto enounced. These laws, scientifically exact, are illusory in practice, because their application would require either an unlimited increase of the electro-motor force, which would render insulation impossible, or the indefinite decrease of the quantity of energy transported, which would render the operation useless. The problem may, however, be practically solved by connecting together a larger or smaller number of machines, not in tension but in quantity. There is nothing to be gained by the construction of machines of colossal dimensions.

Colouring-Matters and Colours at the Universal Exhibition of 1878 (Continued).—M. Lauth.—This memoir opens with the strange assertion that "almost all the indigo consumed is furnished by three countries, the Dutch Indies, the French Indies, and Central America"! (All these three regions collectively do not yield as much indigo as does British India.)

Les Mondes, Revue Hebdomadaire des Sciences.
No. 14, 1882.

Influence of the Coercitive Force upon the Heat produced by Magnetisation.—L. Pilleux.—A fragment of iron which is being magnetised becomes heated in an appreciable manner. The author proves that it is magnetisation and not the induction-currents which heats the iron cores of electro-magnets, and the coercitive force of these cores plays in this case the same part as the resistance to the passage of electricity when a metal wire is heated by the current of the battery.

Influence of Light upon Grapes.—Dr. A. L. de Villanova.—Grapes exposed to solar light contain more sugar by 3.79 per cent and less acid by 1.23 per cent than such as have remained in darkness.

No. 15, 1882.

Easy Process of Magnetisation.—The so-called method of M. Elias, which has been used by M. Jamin and carefully studied by M. Gaugain, is as follows:—A coil of thick wire is traversed by an intense current; it is composed of 10 to 20 spirals, and is very short in its axial dimension. The plate or rod of steel to be magnetised is passed through it, and a few passes suffice to give saturation.

No. 16, 1882.

The Battery and the Decomposition of Water.—Up to the present day physicists agree that it requires more than 34.5 calories to decompose pure water in a

voltameter with platinum plates. Thus, a Daniell's element does not produce this decomposition, as it furnishes a tension only equal to 24 to 25 cal. M. Maiche shows that water can be decomposed by a very feeble battery, such as an iron-copper element, which is figured in *Les Mondes*.

New Improvement in Electric Batteries.—M. Reynier.—This new form of battery is composed of zinc-copper elements depolarised by copper sulphate. It owes its special properties to the use of zinc plates closely partitioned. There is a transformation of copper sulphate into zinc sulphate, whilst zinc is dissolved and metallic copper separated.

No. 17, 1882.

Heat and Magnetisation.—D. Tommasi.—The heating of iron during magnetisation has been pointed out by M. L. Pilleux as well as by the author.

A Little Illusion.—J. Plateau.—This paper, describing an experiment which at first sight seems to realise perpetual motion, cannot be usefully reproduced without the accompanying illustration.

Reduction of Silver Bromide by Light.—D. Tommasi.—It appears from the author's experiments that moist silver bromide loses about 2.30 per cent of bromine on exposure to the sun. The process is rather a dissociation than a decomposition. A very small quantity of the bromide is dissolved into a basic bromide, and ultimately into free silver and bromine if the exposure is prolonged. The brown bromide of silver contains very variable quantities of bromide, of basic bromide, and of silver.

The Electrolysis of Distilled Water.—D. Tommasi.—Already noticed.

Distribution of Electricity.—A. Hamon.—An account of the system of E. Hospitalier, which requires the three accompanying illustrations.

Annales de la Société des Sciences Industrielles de Lyon.
No. 3, 1881.

This number contains no chemical matter.

MISCELLANEOUS.

Fire Risks of Electric Lighting.—The Society of Telegraph Engineers and of Electricians has appointed a Committee to consider and report upon the rules which they would recommend for adoption for the prevention of fire risks arising from the use of the electric light. The names of the members of the committee are as follows:—Professor W. G. Adams, F.R.S., Sir Charles T. Bright, T. Russell Crompton, M. Inst. C.E., R. E. Crompton, W. Crookes, F.R.S., W. De la Rue, F.R.S., Professor G. C. Foster, F.R.S., E. Graves, Professor D. E. Hughes, F.R.S., W. H. Preece, F.R.S., Alexander Siemens, C. E. Spagnoletti, A. Stroh, Sir William Thomson, F.R.S.

American Association for the Advancement of Science.—The Thirty-first Meeting of the Association will be held at Montreal, Canada, commencing at 10 o'clock, a.m., on Wednesday, the 23rd of August, 1882; under the presidency of J. W. Dawson, LL.D., F.R.S., Principal of McGill University, Montreal. A large local Committee has been formed, and through its several sub-committees is actively engaged in perfecting the local arrangements for the meeting, which will soon be announced by special circular. It is only necessary to state here that the members of the committee are desirous of doing everything in their power to promote the objects of the Association, and that their circular will contain information relating to the local arrangements, hotels and boarding-houses, and the special rates of transportation;

also a general programme for the week. The Headquarters of the Association will be at McGill University, where members will register as soon as possible after arrival. The hotel headquarters will be at the Windsor. The offices of the Local Committee and of the Permanent Secretary will be at the University. The General Sessions and the meetings of the Sections and Committees will all be held in the University buildings. The particular rooms will be designated on the programme for Wednesday. Members expecting to attend the meeting are particularly requested to notify the Local Secretaries at the earliest moment possible. At the Boston meeting several changes in the Constitution were proposed, which were adopted at Cincinnati. As a result of these changes the scope of the Association has been extended, and the sections have been entirely re-organised, so that there are now nine sections of equal standing, each presided over by a Vice-President, and having its own Secretary and Sectional Committee. The new arrangement of the sections is as follows:—

Sec. A—Mathematics and Astronomy. Sec. B—Physics. Sec. C—Chemistry, including its applications to Agriculture and the Arts. Sec. D—Mechanical Science. Sec. E—Geology and Geography. Sec. F—Biology. Sec. G—Histology and Microscopy. Sec. H—Anthropology. Sec. I—Economic Science and Statistics.

All communications relating to the local arrangements for the meeting must be addressed to one of the Honorary Local Secretaries at the rooms of the Natural History Society, University Street, Montreal. All matters relating to membership and to the presentation of papers will be attended to by the Permanent Secretary. The address of the Permanent Secretary will be Salem, Mass., until August 17th; after that time and until the meeting has adjourned, his address will be Windsor Hotel, Montreal, Canada.—F. W. Putnam, Permanent Secretary, Salem, Mass., May, 1882.

Officers of the Montreal Meeting:—

President—J. W. Dawson, of Montreal.

Vice-Presidents—A. Mathematics and Astronomy, W. Harkness, of Washington; B. Physics, T. C. Mendenhall, of Columbus; C. Chemistry, H. C. Bolton, of Hartford; D. Mechanical Science, W. P. Trowbridge, of New Haven; E. Geology and Geography, E. T. Cox, of San Francisco; F. Biology, W. H. Dall, of Washington; G. Histology and Microscopy, A. H. Tuttle, of Columbus; H. Anthropology, Daniel Wilson, of Toronto; I. Economic Science and Statistics, E. B. Elliott, of Washington.

Permanent Secretary—F. W. Putnam, of Cambridge.

General Secretary—William Saunders, of London, Ontario.

Assistant General Secretary—J. R. Eastman, of Washington.

Secretaries of the Sections—A. Mathematics and Astronomy, H. T. Eddy, of Cincinnati; B. Physics, Chas. S. Hastings, of Baltimore; C. Chemistry, Alfred Springer, of Cincinnati; D. Mechanical Science, Chas. B. Dudley, of Altoona; E. Geology and Geography, C. E. Dutton, of Washington; F. Biology, Charles S. Minot, of Boston; G. Histology and Microscopy, Robert Brown, Jr., of Cincinnati; H. Anthropology, Otis T. Mason, of Washington; I. Economic Science and Statistics, F. B. Hoogh, of Lowell.

Treasurer—William S. Vaux, of Philadelphia.

Standing Committee—The Officers above named, and Past Presidents—James D. Dana, of New Haven; James Hall, of Albany; Stephen Alexander, of Princeton; Isaac Lea, of Philadelphia; F. A. P. Barnard, of New York; J. S. Newberry, of New York; B. A. Gould, of Boston; T. Sterry Hunt, of Montreal; Asa Gray, of Cambridge; J. Lawrence Smith, of Louisville; Joseph Lovering, of Cambridge; John L. LeConte, of Philadelphia; J. E. Hilgard, of Washington; William B. Rogers, of Boston; Simon Newcomb, of Washington; O. C. Marsh, of New Haven; George F. Barker, of Philadelphia; George J. Brush, of New Haven.

NOTES AND QUERIES.

*. Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Soluble Oil.—There is an article used by finishers called "soluble oil," one variety of which seems to consist largely of glycerin; the other is a kind of liquid soap and smells of castor oil. Can any of your readers give me any information as to how these are made?—A FINISHER.

MEETINGS FOR THE WEEK.

- MONDAY, May 22nd.—Society of Arts, 8. "Book Illustration: Old and New" (Cantor Lectures), by J. Comyns Carr.
Geographical, 2. (Anniversary).
TUESDAY, 23rd.—Institute of Civil Engineers, 8.
Royal Medical and Chirurgical, 8.30.
Royal Institution, 3. "Digestion," by Professor A. Gamgee.
Society of Arts, 8. "The Gold Fields of West Africa," Capt. Cameron, R.N., and Capt. Richard Burton.
Anthropological Institute, 8. "On Systems of Land Tenure in Different Countries," Sir H. Bartle Frere, G.C.B., F.R.S., &c.
WEDNESDAY, 24th.—Society of Arts, 8. "English and Foreign Technical Education," by E. C. Robins, F.S.A.
Geological, 8.
THURSDAY, 25th.—Royal Institution, 3. "The Metals," by Prof. Dewar.
Royal, 4.30.
Society of Arts, 8. "Recent Passages of Zulu-Kafir History," by Dr. R. J. Mann.
FRIDAY, 26th.—Royal Institution, 8. "Sacred Laws of the Hindus," by Sir Henry S. Maine, at 9.
Quekett Microscopical Club, 8.
SATURDAY, 27th.—Royal Institution, 3. "Poetry and its Literary Forms," Professor D. Masson.

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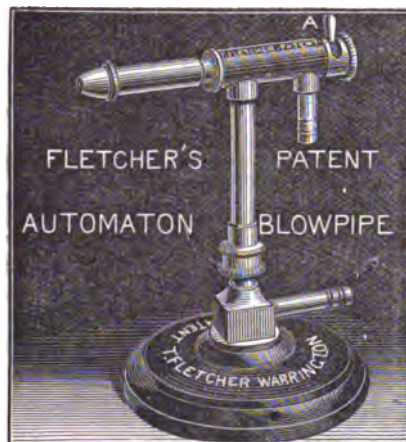
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THE CHEMICAL NEWS

Vol. XLV. No. 574

27 MAY 82

SOME OF THE DANGEROUS PROPERTIES
OF DUSTS.

By F. A. ABEL, C.B., F.R.S.
President of the Institute of Chemistry.

(Concluded from p. 215.)

To sum up: it has not been difficult, as will have been seen from the foregoing, to demonstrate experimentally that the existence of a very small proportion of fire-damp in the air of a mine may determine the propagation of flame by coal-dust, ignited by the explosion of some local accumulation of a gas mixture, or by the inflammation of gas suddenly disengaged, or even by the flash from a blown-out shot. It has also been clearly established that in so-called fiery mines the air is never likely to be actually free from fire-damp, and that as much as 2 per cent may exist in the return air of a very efficiently ventilated mine of that class. It must therefore be regarded as a thoroughly well-grounded conclusion that, in many disastrous explosions coal-dust is the chief agent of destruction, and it is indisputable that but few explosions occur of which the effects have not been more or less considerably extended and aggravated by the coal-dust which is raised by the fire-damp explosion. It may also be admitted as not improbable that in some instances the influence of dust may, apart from its combustibility (as described), determine the ignition of a mixture of air and dust with a small proportion of fire-damp by the flame which a blown-out shot, or the accidental ignition of some local accumulation of explosive gas-mixture, has produced. Lastly, it is conceivable, as contended by Freire Marreco, Galloway, and some Continental observers, that a mixture of an inflammable coal-dust and air may even, in the complete absence of fire-damp, both originate and carry on to some distance explosions which, though much inferior in violence to those developed through the agency of gas-mixtures, will be at least equal to them in regard to the disastrous effects on the lives of those exposed to them. That mixtures of coal-dust and air alone may have the power to carry on the explosion originally caused and disseminated by a gas, air, and dust mixture, into regions where no gas whatever exists, will now be generally admitted. The great disturbance of the air which must proceed in immediate advance of the rush of flame produced by the ignition of a mixture of gas and air charged with coal-dust will, in many mine-workings, raise a dense cloud immediately in front of the flame, and the latter will thus be fed as it advances. Mr. Galloway concludes, as the final result of his experiments with coal-dust, that the presence of fire-damp is altogether unnecessary to bring about a coal-mine explosion; but, admitting that the result of certain experiments may seem to favour this conclusion, its realisation necessitates the fulfilment of conditions which cannot but be very exceptional, and its acceptance is certainly unnecessary to add to the formidable character of coal-dust as a source of danger and an agent of destruction in mines.

Whether an explosion originates with, or is chiefly caused by, the production of a mixture of fire-damp with air in such proportions as to be more or less rapidly and violently explosive; whether the originating cause be the reciprocal influence of a small proportion of fire-damp and of coal-dust (or dust of other descriptions of minerals occurring in coal-mines) co-existing in the air of a mine;

whether, possibly, it simply originates with a mixture of very inflammable coal-dust and air in the complete absence of fire-damp; or whether, lastly, only the very limited concession be made that coal-dust will add to the extent, and increase the burning effect, of a fire-damp explosion; in any case, the existence of dust in abundance, and in a dry state, in coal-mine workings, must be recognised as a source of danger not greatly inferior to that caused by local accumulations, or the accidental liberation, of fire-damp. The possibility of dealing with this source of danger should therefore be as much an object of earnest work as has been the improvement of ventilating arrangements for mines.

It being generally impracticable effectually to deal, by actual removal, with the continual accumulation of dust in mine-workings, the only available method of diminishing the dangers arising from its constant production appears to be that of maintaining the floor in the roads, &c., in a damp condition by efficient watering arrangements, almost continually applied. The high temperature of the mine, in many instances, must often render this a difficult and costly process, on account of the rapidity with which the water will evaporate; hence attempts have been made to apply hygroscopic substances (such as calcium chloride, sea-salt, or rock-salt) in conjunction with water, or to use brine, with a view to retard its evaporation, and some successful results appear to have recently attended their application in several districts. In some instances, with improved appliances for the uniform and periodical distribution of sufficient water, the maintenance of mine-roads in a sufficiently damp condition to prevent dust from being raised in any considerable quantity appears to have been accomplished with fair success. There are, however, localities where it is almost impracticable so maintain the floor of the roads in a damp condition, in consequence of the great increase thereby of the tendency to their being gradually raised by the pressure to which they are subject.

Apart from the effects of dust in augmenting the disastrous results of such fire-damp explosions as may arise from the existence of a defective, or an open, safety-lamp in the vicinity of an accumulation of gas, or of a locality where a sudden outburst of gas occurs, the *blasting* of coal or of rock, in those parts of a mine where fire-damp may exist, if even only in very small quantities, constitutes the chief source of accidents in which coal-dust may have played an important share. There is no doubt, therefore, that the elaboration of really safe methods of getting coal in places where blasting by powder is now resorted to, and of removing the harder rock in the working of drifts where fire-damp may exist, will most importantly contribute towards the diminution of danger arising from the accumulation of dust in mines. The substitution of efficient coal-cutting machines for blasting may to some extent supplant the use of powder, and the employment of compressed air as an agent for bringing down coal or rock has been made the subject of ingenious contrivances, which appear, however, as yet, to labour under some disadvantages in regard to cost, facility of use, and general efficiency. Attempts have been made to render the employment of powder in the presence of fire-damp safe, by using it in conjunction with water. In the first instance it was proposed by Dr. Macnab to bring the latter into direct operation as the cleaving or blasting agent by inserting a cylinder containing water into the blast hole, and connecting it with a very strong external vessel, in which the powder charge was fired, much as the powder charge is fired in the powder chamber of a gun, the generating gas being brought to bear upon the confined column of water, and causing the latter to exert a rending force upon the coal by which it was surrounded. As the results furnished by this method of operation were not promising, the comparatively very simple expedient was resorted to by Dr. Macnab of employing water simply as tamping in a charge hole, a cylinder containing the liquid and of suitable length to fill the hole, being inserted

* A Lecture delivered at the Royal Institution of Great Britain, Friday, April 28, 1882.

over the charge of powder. In the event of a charge blowing out, the dispersion of the water in a very finely-divided condition was relied upon to effect the extinction of the volume of flame which, under these conditions, would be projected into the air of the mine. Some carefully-conducted experiments, with blast holes charged by this method and surrounded by an explosive gas-mixture, showed that occasionally no ignition of the gas resulted from the blowing out of the shot, but that in most instances, the conditions of the experiments being the same, the gas-mixture in front of the blast hole was exploded, when the shot blew out. It is possible that a careful regulation of the charge and length of tamping may render this mode of operation a comparatively safe one, though it may be doubtful whether absolute reliance could be placed upon the invariable extinction of flame in the case of blown-out charges. When the attention of the Royal Commission was directed to the subject of the dangers attending the employment of explosives in coal-mines, it occurred to Mr. Abel to attempt the application to the getting of coal of the principle which he developed some years ago, in the course of his researches on explosive agents, namely, the sudden transmission in all directions of the force exerted instantaneously by a *detonation*, by surrounding the detonating charge with water. It was found in a large number of experiments that when comparatively small charges of gun-cotton or dynamite (the latter being preferable) were enclosed in cylinders of light metal or paper filled with water, and occupying the entire available space (or nearly so) in a blast hole, the detonation of the charge in holes of excessive strength, when employed in proper proportion to the amount of water by which it was surrounded, was always accomplished without ignition of the explosive gas-mixture with which the opening of the blast hole was surrounded. The interesting fact was, moreover, established, by operations carried out in hard coal in Lancashire, that the action of the detonating charge is modified to great advantage, by enclosing the envelope in a long column of water. Instead of exerting a powerfully crushing or disintegrating action, confined within comparatively narrow limits, whereby a charge of gun-cotton or dynamite is rendered of little value as a means of getting coal when used in the ordinary way, the distribution of the explosive force in all directions by the column of water causes it to exert a cleaving or splitting action even superior to that exercised by ordinary blasting powder. The further development of this method of applying detonating agents to blasting purposes in coal-mine workings appears, therefore, well worthy of attention.

Another method of getting coal, which, though not new in itself, has been applied in a novel manner and with most promising results by Messrs. Smith and Moore, has the great advantage of dispensing entirely with the use of explosive agents, and of any but the most simple mechanical appliances.

It consists in applying the force which quicklime will develop if confined, and made to combine under that condition with water, whereby it undergoes very considerable expansion, a large amount of heat being at the same time developed. Messrs. Smith and Moore convert the freshly burned and crushed quicklime into very compact cylindrical masses, or cartridges, having a small groove on one side, so that when the requisite number of cylinders are inserted symmetrically into the mechanically drilled hole in the coal, which they fit accurately, a narrow pipe, with perforations along its entire length, enclosed in a tight-fitting stocking of spent webbing, and provided with a stopcock, may be inserted into the side of the charge, which is afterwards tamped in the usual manner. The proportion of water necessary to slake the lime, *plus* an excess of about one-sixth, is then forced into the hole through the pipe by means of a simple hand syringe, and the stopcock of the pipe being closed, the operation is complete. In a brief space of time sounds indicative of the cracking of the mass of coal which contains the cartridge show that the expansion of the lime by its union

with the water, and the very considerable development of steam within the cartridges, are performing their work, and after an interval of time varying with the strength of the part of the seam operated upon, the coal is detached in large blocks. The holes can be charged so rapidly that a considerable number may be put into operation in quick succession by one or two men.* As the action of the charge occupies some little time (fifteen or twenty minutes), they really come into operation together, and in this way large faces of hard coal, in long-wall workings, are brought down with ease and certainty. Whether these compressed lime cartridges can be applied with any success in stone still remains to be determined, but in point of cost, simplicity, and above all safety, this method of detaching coal appears to rank before any other yet tried. Besides entirely avoiding the use and production of flame or fire in the blasting of the coal, the operation is conducted gradually and almost noiselessly, and the raising of dust by the more or less violent concussions which attend the employment of explosives in any form or manner is avoided.

It is insisted upon by a great majority of those most competent to judge, that the employment of explosives cannot be dispensed with in the profitable working of coal mines. That the use of gunpowder in the ordinary way, even with strict attention to all practicable precautions, is a most prolific source of accident, has long been recognised. The development of safe methods of applying explosive agents, or of simple and effective substitutes for them, is therefore of such paramount importance in securing protection to the miner against the dangers of fire-damp and of coal-dust, that those who are entrusted with the management of coal mines should spare no exertions to test rigorously but fairly the merits of any proposals which afford promise of success in this direction.

THE DISSOCIATION OF CHLORINE.†

By A. PERCY SMITH, F.I.C., F.C.S., Assistant Chemical Master, Rugby School, and W. B. LOWE, M.A., F.C.S., Storrington.

In the summer of 1879, Meyer showed (CHEMICAL NEWS, vol. xi., p. 49) that when *nascent* chlorine was heated to a temperature of 1242° to 1567° C., its vapour density was 1.63, or $\frac{1}{3}$ of the vapour-density at 600°. It occurred to one of us that if chlorine was passed through a tube into potassium iodide solution, less iodine might be liberated when the tube was heated than when cold. A trial was made by evolving chlorine from weighed quantities of manganese dioxide and hydrochloric acid, the evolved gas being passed through the stem of a tobacco pipe heated by a combustion furnace. It was found that about one-ninth less iodine was liberated when the tube was heated than when cold. The results were not uniform, owing to the porosity of the tube and presence of aqueous vapour.

At about this time, Meyer's and Züblin's results appeared in CHEMICAL NEWS, vol. xli., p. 135; they, having filled a heated porcelain vessel with chlorine, and displaced it into potassium iodide solution by a current of carbon dioxide, found the vapour-density to be 2.61, hence concluding that *free* chlorine was not dissociated.

In December, 1881, we submitted the question to further experiment. A U-tube of 55 c.c. capacity was provided with terminal india-rubber tubes closed with

* In one of several operations of this kind recently witnessed by the Lecturer at Shipley Collieries, Derby, in the "deep hard seam," which is nearly 3 ft. thick, ten shots were fired (i.e., watered) together, bringing down a block of coal 39 ft. long by 3 ft. thick and 2 ft. to 10 in. high, weighing about 10 tons. The average time occupied in boring a hole (by mechanical drill), charging and tamping it, and watering the charge, was twenty minutes. The usual operation of bringing down this very hard coal, by wedging, is exceedingly slow and laborious.

† Abstract of a Paper read before the Chemical Society, Feb. 16, 1882.

pinchcocks, which could always be clamped at exactly the same places, thus ensuring a constant volume in each experiment, which volume was 58 c.c. This U-tube was filled with chlorine, by permitting a washed and dried stream of the gas to flow through it at normal pressure. When full both clips were closed simultaneously. One end of this chlorine tube was then connected with a tube of glazed Berlin porcelain, passing through a combustion furnace, and the other end of the porcelain tube with a pair of nitrogen bulbs, containing a solution of potassium iodide, joined on to which was a water pump to exhaust the train of apparatus and draw the chlorine through it. Upon removing the clip between the U-tube and the furnace, and cautiously admitting air by the other clip, the chlorine passed slowly through the bulbs. When no more iodine was liberated, the contents of the bulbs were titrated with sodium thiosulphate. Several experiments were made in this manner without heating the porcelain tube, and in every instance the amount of iodine liberated corresponded to the amount of chlorine used.

Cl used.	Temp.	I liberated.	Duration of Expt.
0.01838 grm.	7.5°	0.65786	5 mins.

A great number of experiments were then made with the tube heated to various temperatures, from dull redness up to 1030° C., and although less iodine was liberated than with the tube cold, the results were not concordant. The source of error was at length found to be due to insufficient drying of the chlorine (since hydrochloric acid was found in the neck of the first N bulb). Additional precautions were therefore taken in its preparation; the water in the wash bottles was changed each time of using, and extra drying tubes, containing alternate layers of cotton-wool and powdered calcium chloride, added. The air which was drawn through the chlorine tube during the course of an experiment was also first purified by passing through sulphuric acid, potassium hydrate, and over calcium chloride.

The time taken by each experiment varied greatly. If the chlorine was allowed to pass rapidly through the heated tube, more iodine was liberated than when the chlorine passed more slowly and therefore was heated for a longer time. The method which gave the best and most constant results was to keep the clip between the U-tube and the furnace open, and the other clip shut, and only to open it momentarily at intervals. The time taken for all the chlorine to pass through the heated tube was thus about three-quarters of an hour.

When the chlorine was drawn rapidly through the apparatus it was accompanied by a "white smoke," which was insoluble in water, and had no action on litmus paper or on a glowing match. This "smoke" was formed in the porcelain tube, and diminished in quantity as the experiment drew towards a conclusion. The porcelain tube was not acted upon by the chlorine.

In the final experiments, which extended over a long period of time, the "smoke" remained in the porcelain tube (or at any rate was not seen) so long as the chlorine was only permitted to enter in an intermittent manner. When, at the end of the experiment, the clip was opened and air drawn through, the "smoke" appeared in the bulbs, but was of less quantity than in the previous cases. Throughout the experiments the water-pump was kept working, so as to prevent any leakage of chlorine through the joints of the apparatus.

It would be waste of space to give the particulars of all the experiments. The following were results obtained, after eliminating all sources of error:—

Cl used.	Temp. of Air.	Tube.	Temp. of Furnace.	Iodine Liberated.	Duration of Expt.
0.01838	7.5° C.	Porcelain	1030°	0.48768 grm.	30 mins.
"	"	"	"	0.49022 "	55 "
"	"	"	"	0.49149 "	45 "
"	"	"	cold	0.65786 "	5 "

The mean of these experiments gives the amount of iodine liberated as 0.48979 grm., which corresponds to

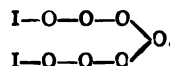
0.01369 grm. chlorine; so that 0.01838 grm. Cl at 7.5° C., becomes 0.01369 grm. Cl at 1030° C., or, as 1 : 0.744.

We forbear to advance any hypothesis to account for this result, but we may call attention to the fact that Meyer found the vapour-density at 1028° C. to be 1.89, which is to the vapour-density at 600° (2.46) as 0.76 : 1.

ON THE PHYSIOLOGICAL ACTIVITY OF SUPER-OXYGENATED MOLECULES, ESPECIALLY THOSE OF QUININE IODATE AND BROMATE.

By CHARLES A. CAMERON, M.D.,
Professor of Chemistry R.C.S.I.

THE author has come to the conclusion that the bromates and iodates are physiologically more active than the corresponding bromides and iodides. The facts in support of the theories that physiological activity was proportional to high atomic and molecular weights, and was also due to the unsaturated condition of molecules, were considered and criticised. The facts which supported the theory that unsaturated molecules produced a more powerful action upon the system than saturated molecules were more convincing than the facts upon which the other theories rested. The author considered that the term "super-oxidised" might, for want of a better one, be applied to molecules containing a larger number of oxygen atoms than were requisite to saturate the other atoms present. The iodates, periodates, bromates, and perbromates were composed of super-oxidised molecules. Super-oxidised molecules were perhaps to be properly regarded as unsaturated; their oxygen atoms were as imperfectly saturated as were the carbon atoms in carbon monoxide. In replacing other elements, bromine and iodine invariably act as monads. If they are true monads, then, in such a compound as periodic anhydride, we have two imperfectly satisfied bonds of oxygen—



In the compound KI, each of its two atoms has its unit of equivalence perfectly satisfied by combination with the other atom; the compound is therefore saturated and stable. The addition of four oxygen atoms to KI produces an unsaturated and unstable body, and therefore one likely to be physiologically more active than the stable KI, or KBr, or NaCl.

In 1869 the author introduced the ferric iodate ($\text{Fe}_2\text{6IO}_3$) as a substitute for the unstable ferrous iodide, and the therapeutic value of the former seems to have been well established. More than a year ago he also suggested the employment of quinine iodate and bromate. These compounds, especially the former, have been largely prescribed by the medical faculty in Dublin, and have been found of great value in sluggish cases of pulmonary congestion, neuralgia, severe articular pains, malarial enlargement of the spleen, and secondary syphilitic disease. The quinine iodate and bromate have been used chiefly in the form of a granulated effervescent preparation, containing 2 grs. of the quinine salt (a dose) per drachm.

Of iodate of quinine only very meagre accounts are to be met with in chemical books or journals. The author prepared it by neutralising freshly-precipitated quinine hydrate with iodic acid dissolved in not less than 8 parts of water. The iodate forms in exceedingly minute needles of pearly lustre, which at 100° C. become yellowish. Dried at 60°, quinine iodate suffers no loss of weight when kept *in vacuo* over sulphuric acid. The mean result of three determinations showed that it contained 21.8 per

* Abstract of a Paper read before the Medical Society of the College of Physicians, Dublin, May 3, 1882.

cent of iodine. It appears, therefore, to have the following composition: $C_{20}H_{24}N_2O_2, HIO_3$. In accordance with this formula the amount of iodine should be 22.92 per cent; the salt was, however, very faintly alkaline from presence of a little free quinine. Quinine iodate dissolves freely in spirit of wine and hydrochloric acid, less freely in ether, and sparingly in strong alcohol and chloroform. It is more or less soluble in all the vegetable acids. 1 part dissolves in 700 parts of cold water; strong sulphuric acid merely colours it a light yellow, and the mixture diluted with water becomes colourless. At 100° C. it undergoes slight decomposition.

Of quinine bromate no mention can be found in the books or journals. It may be prepared by precipitating barium bromate by quinine sulphate, or by neutralising bromic acid with quinine. It forms asbestos-like masses, which under the microscope are found to consist of very long needles. The salt when dry resists the heat of the water-bath, but its solution when evaporated, especially in a platinum dish, leaves a bluish black residue. It is much more soluble than the iodate, namely, to the extent of 1 part in 250 parts of water. Touched with strong sulphuric acid, it detonates, sends off a puff of smoke, and nearly wholly disappears. It is soluble in hydrochloric, acetic, dilute sulphuric, and other acids; also in spirit of wine, and but very sparingly in ether and chloroform.

Shortly after the administration of quinine iodate, both iodic and hydriodic acids are found in the urine; later on the quinine makes its appearance. The continued ebullition of quinine bromate in water causes the solution to acquire a blue colour, exactly like that of indigo. The colour is bleached by nitric acid, but is not affected by dilute sulphuric or hydrochloric acid, or by ammonia.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

The following are the relative sensibilities of the principal reactions:—

1. Metallic zinc. One-sixth milligramme of gallium is easily separated without sensible loss from a litre of liquid, even in presence of many foreign substances. At this degree of dilution we are still far from the limit of the sensitiveness of this method. The difficulty of procuring pure zinc unfortunately restricts in practice the use of this metal in delicate analyses.

2. Cupric hydrate.—The same sensitiveness as zinc.

3. Copper and cuprous oxide.—The same exactitude as the two former. Copper and its oxides being easily obtained in a state of purity are to be recommended whenever their use is practicable.

4. Arsenic sulphide.—Very sensitive, but perhaps slightly inferior to the three former reactions. It withdraws the greater part of 1-6th of a milligram of gallium from a litre of liquid.

5. Manganese sulphide.—With 1-6th milligram gallium per litre we obtain at the end of the operation the ray $G_a \alpha 417$, but less bright than if we had made use of arsenic sulphide.

6. Potassium ferrocyanide.—1-205,000th of gallium is precipitated and collected upon a filter without sensible loss; we may therefore go further.

7. Boiling after super-saturation with ammonia.—This process gives rise to losses, which seem to range between 1 and 1.5 m.grm. per litre. In a rigorous analysis the ammonia is expelled in the water-bath, or the mixture is boiled in a flask placed in a slanting position to prevent loss by spitting.

8. Carbonate of lime, hot, then ammoniacal ebullition of the hydrochloric solution of the mixture of calcium carbonate and gallium sesquioxide.—The losses, slightly higher than those in the preceding method, rise to 1.5 m.grms. per litre of the original liquid.

9. Calcium carbonate, hot, after reduction of the liquid with sodium sulphite, then ammoniacal ebullition of the hydrochloric solution of the mixture. The loss is about 1.5 m.grms. per litre.

Quantitative Analysis of the Salts of Gallium.

Separation from Cesium, Rubidium, Potassium, Sodium, Lithium, and Ammonium.—When the proportion of gallium is not very small, the simplest method is to super-saturate the hydrochloric solution with ammonia, and to boil until a litmus paper, previously placed in the liquid, takes a distinctly red tint. Water must be added to make up for the loss by evaporation. The gallium oxide is received upon a filter, washed, dried, and ignited. To separate the traces of gallium entangled in a considerable mass of alkaline salts, the boiling solution is treated with cupric hydrate. The mixture of gallium sesquioxide and cupric oxide is re-dissolved in a decided excess of hydrochloric acid; the copper sulphide, which is then thrown down by sulphuretted hydrogen, does not carry gallium with it, and the liquid concentrated to a small bulk is super-saturated with ammonia, and then boiled for a long time.

Separation from the Alkaline Earths.—If the gallium is moderately large in quantity it may be at once precipitated by ammoniacal super-saturation, followed by prolonged boiling; the alkaline earthy oxides remain in solution. Traces of gallium sesquioxide mixed with much of the salts of barium, strontium, or calcium, are separated by means of cupric hydrate. The baryta and the bulk of the strontia and lime, may also be precipitated by sulphuric acid from a liquid more or less alcoholic. After evaporation of the alcohol and concentration to a small bulk, the gallium is recovered by ammoniacal ebullition, or by cupric hydrate, according to the degree of exactness required. When the former method has been used the precipitate must be ignited strongly to expel completely any traces of sulphuric acid.

Separation from Magnesia.—Prolonged ebullition of a solution super-saturated with ammonia succeeds well. The process with cupric hydrate is suitable where there are small quantities of gallium along with much magnesia.

Separation from Alumina and Chromic Oxide.—The most convenient process is to precipitate the gallium with ferrocyanide from a very acid hydrochloric solution, containing at least from a fourth to a third of its bulk of concentrated acid. When the gallium is in small proportions (less than 1-100,000th), it must be allowed to stand one day or two days for the precipitate to form. It is then received on a filter, washed with water containing a fourth to a third of its bulk of hydrochloric acid. The filter is dried at a gentle heat and ignited. The result is a mixture of the oxides of gallium and of iron, which are separated, as will be explained in the course of these researches. The almost inevitable formation of a little Prussian blue in the highly acid liquid presents no inconvenience, and merely increases the proportion of ferric oxide to be afterwards separated from the gallium oxide. Ferrocyanide enables us to separate and determine gallium mixed with 2000 times its weight of alumina or chromic oxide. Nevertheless, slight traces of gallium diffused among enormous masses of alumina or chromic oxide, may escape the action of the ferrocyanide. They are collected then by "entanglement in metallic sulphides (those of zinc, arsenic, or manganese) formed in alkaline or acetic solutions." Precipitation with sulphuretted hydrogen in a solution containing ammonium acetate, free acetic acid, and arsenious acid seems preferable. The galliferous arsenic sulphide, previously washed with sulphuretted hydrogen water containing a little acid ammonium acetate, is treated with aqua regia, and evaporated almost to dryness in presence of an excess of hydrochloric acid to expel nitric acid. The arsenic acid is then reduced by sulphurous acid or an alkaline sulphite, diluted with water strongly charged with hydrochloric acid, and treated with sulphuretted hydrogen. The arsenious sulphide precipitated is washed with sulphuretted hydrogen

water containing hydrochloric acid. The gallium remains in the liquid, and is separated by concentration to a small bulk, and boiling after super-saturation with ammonia.—*Comptes Rendus*.

ACTION OF SULPHURETTED HYDROGEN UPON A SOLUTION OF NICKEL SULPHATE IN THE COLD.

By M. H. BAUBIGNY.

On a former occasion the author called attention to the influence exerted by the comparative weights of acetic acid and nickel oxide upon the formation of nickel sulphide when an acid solution of nickel acetate is treated with sulphuretted hydrogen. A fact of the same nature may be verified with nickel sulphate. The results obtained under conditions otherwise alike are independent of the state of concentration of the metallic solution.

With zinc, as is said by Berzelius, and as the author has verified, the precipitation ceases when the liquid becomes acid up to a certain point. With nickel nothing of the kind occurs, and hence the quantity of nickel sulphide formed by sulphuretted hydrogen is a function of the duration of the experiment.

These results are independent of the state of saturation of the solution by the sulphuretted hydrogen gas, for the precipitation presents the same properties if the metallic solution is saturated at 0°, or at 30°, at which latter temperature the solubility of sulphuretted hydrogen in water is about half what it is in the same liquid at 0°. The precipitation is merely less rapid.

As the weight of nickel sulphide formed increases with the duration of the experiment, it results that the quantity of sulphuric acid set at liberty increases also, and as the reaction takes place, other things being equal, with a dilute or concentrated solution of nickel sulphide, we may believe that the formation of the sulphide is always independent of the weight of the free acid to the weight of the undecomposed sulphate. The foregoing observations, if thus interpreted, do not lead to an exact conclusion, for this progressive precipitation of the sulphide under the conditions laid down above is only due to a secondary reaction in which the nickel sulphide formed intervenes by forming a hydrosulphate of the sulphide.

The action of the sulphuretted hydrogen under the above conditions is annulled as soon as the solution contains free sulphuric acid equal in weight to one-fourth of the acid of the salt.

The formation of nickel sulphide by sulphuretted hydrogen and nickel oxide is a function of the ratio of the weights of the acid and of the metal present, and not of the relative acidity of the liquid, i.e., the weight ratio of the free acid and of the water.

There is in this fact a lesson of great analytical importance from which the author has derived advantage for more than three years in the separation of nickel and zinc. For zinc, as will be shown on a future occasion, the precipitation of the sulphide is a function of the relative acidity of the liquid and not of the relative weights of acid and metal present, so that by diluting the solution of zinc in proportion to the quantity of free acid, it may be precipitated as sulphide entirely and alone.—*Comptes Rendus*.

Detection of Alkalies in Silver Nitrate.—M. Stolba.—The salt is dissolved in the smallest possible quantity of water; the liquid is filtered, and hydrofluosilicic acid is added drop by drop. If this produces a turbidity, an alkaline salt is present. If the liquid remains limpid, it is mixed with an equal volume of alcohol, which will precipitate the slightest traces of alkali if present.—*Journal de Pharmacie et de Chimie*.

A NEW REAGENT FOR NITROUS ACID.

By Dr. A. JORISSEN.

If nitrous acid is allowed to act upon an alcoholic solution of rosaniline, the liquid, according to Max Vogel, is coloured at first a splendid violet, then a fine blue, which passes into a dark green, then into a yellowish green, and ultimately into a reddish yellow.

Although other chemists who have been engaged with researches on the constitution of rosaniline have made similar observations to those of Vogel, it does not appear that anyone has proposed to apply this reaction to the detection of nitrous acid. Rosaniline may, however, be used for the detection of traces of nitrous acid, but it is advisable to use a solution in glacial acetic acid in preference to one in alcohol.

If we dissolve 0.01 grm. magenta in 100 c.c. glacial acetic acid, and if 2 c.c. of this solution are placed in a small porcelain capsule, and a trace of solid potassium nitrite be added, the phenomena described by Vogel may be observed. The liquid turns successively violet, blue, green, and finally yellow. The nitrates are without action upon the reagent. If there be added to the test-liquid free mineral acids, the mixture takes finally a yellow colour, but this is due to the formation of a tri-acid salt of rosaniline, and the characteristic red colour of rosaniline can be reproduced by the addition of water. When the change of colour has been occasioned by nitrous acid the original colour cannot be restored by the addition of water, but the liquid remains yellow.

If it is desired to detect a nitrite in a liquid it is concentrated, or by preference evaporated to dryness. When cold a suitable quantity of the reagent is added, when the characteristic play of colours is produced if a nitrite be present. The evaporation to dryness serves to render the reaction more sensitive, as it succeeds better the more concentrated the acetic acid.

In searching for minute traces of nitrous acid the quantity of magenta dissolved in the glacial acid may be proportionally decreased by, e.g., mixing 1 c.c. of the reagent as described above with 9 c.c. of glacial acetic acid.

The author has shown experimentally that the new reagent may be used for the detection of nitrous acid in natural waters in Fresenius's method of distilling with glacial acetic acid. For this purpose 1 c.c. of a solution of 0.5 grm. potassium nitrite in 1 litre of water was added to 100 c.c. of water. This liquid, which contained 0.0005 grm. of the nitrite, was mixed with acetic acid and introduced into a small retort connected with a receiver containing a mixture of 9 c.c. glacial acetic acid and 1 c.c. of the test liquid (the solution of 0.01 grm. magenta in 100 c.c. glacial acetic acid). A few drops of the distillate sufficed to produce the above-described change of colours in the receiver.—*Zeitschrift für Analytische Chemie*.

A RECLAMATION.

ON p. 50 of our present volume we inserted, under the title of "A Chemical Anomaly," a short article translated from the *Revue Scientifique* and *Les Mondes*. In this article the possibility of a certain variability of the atomic weights, or at any rate of the composition of certain compounds, is represented as a suggestion of M. Schützenberger. We have now received a courteous communication from Professor Boutlerow, of St. Petersburg, in which he claims this idea as originally his, and as having been made public in a communication to the Russian Chemical Society more than a year ago. Whilst we have pleasure in inserting this announcement, we do not, of course, desire to make any imputation upon M. Schützenberger, who may have arrived independently at results similar to those of Professor Boutlerow.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 18, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time :—
J. J. Dobbie, B. Brauner.

THE PRESIDENT then called upon Dr. MILLS to read a paper "On the Precipitation of the Alums by Sodid Carbonate," by E. J. MILLS and R. L. BARR. A solution of pure potassio-aluminic alum was prepared, containing 1 per cent of aluminic sulphate, and a solution of pure sodium carbonate containing 0.93038 per cent. The strengths of equal volumes of these solutions would be $\text{Al}_2(\text{SO}_4)_3 : 3\text{Na}_2\text{CO}_3$. The required quantity of sodium carbonate solution having been placed in a beaker, water was added to 100 c.c., and then 100 c.c. of the alum solution. The whole was mixed, care being taken to keep the temperature constant, and left for an hour; the precipitate was then quickly filtered off and weighed. In this way tables and curves were obtained, giving the precipitation with varying quantities of sodium carbonate. The alum solution begins to yield a precipitate when the ratio is about $\text{Al}_2(\text{SO}_4)_3 : \frac{1}{2}\text{Na}_2\text{CO}_3$. It is about half precipitated with $\text{Al}_2(\text{SO}_4)_3 : \frac{1}{3}\text{Na}_2\text{CO}_3$, and completely precipitated in the proportion $\text{Al}_2(\text{SO}_4)_3 : \frac{1}{2}\text{Na}_2\text{CO}_3$. The precipitation takes place in three stages. In the first, 19 c.c. of sodium carbonate are added, and no precipitation takes place; in the second, a continuous precipitation takes place until about half the alum is thrown down, 47 c.c. of sodium carbonate being required. In the third the precipitation proceeds, but with altered constants, and 80 c.c. of sodium carbonate are needed. Similar results were obtained when potassio-chromic alum was used, the three stages being $\text{Cr}_2(\text{SO}_4)_3 : 2\text{Na}_2\text{CO}_3$; $\text{Cr}_2(\text{SO}_4)_3 : \frac{1}{2}\text{Na}_2\text{CO}_3$; the limit of complete precipitation was not determined.

Mr. W. H. PERKIN then read a paper "On Rotary Polarisation by Chemical Substances under Magnetic Influence." So far as this subject has been studied by De la Rive, Becquerel, &c., no definite relationship between the chemical composition of substances and their power of rotating the plane of polarisation, when under the influence of magnetism, has been observed. The object of the author was to discover, if possible, whether any relationship of this kind existed. The apparatus used was similar to that employed by Becquerel, the liquids being placed in tubes closed at their ends with glass plates. The ends of the tubes were inserted a short distance into perforations in the armatures. Water and carbon disulphide were used as standards. The author's results, which were calculated for unit lengths of the fluids, agreed pretty closely with those of De la Rive and Becquerel, but seemed to bear no relationship to chemical composition. On consideration it seemed probable that unit lengths of vapours would give better results. It was soon apparent that the direct estimation would be attended with too many difficulties. The results of the observations obtained with unit lengths of fluids can, however, be referred to the lengths of columns of liquids, which would be formed by the condensation of unit columns of their vapours; in other words, to lengths related to each other in proportion to their molecular weight, making the necessary correction for difference of densities. This can be done by the simple equation—

$$\frac{r \times m w}{d},$$

r being the observed rotation, $m w$ the molecular weight, and d the density. Having made this calculation for the substance under examination, and for the standard with which it is compared, the molecular coefficient of magnetic rotation, or, more briefly, the molecular rotatory

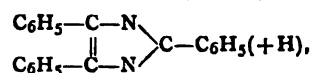
power, can be obtained by dividing the former by the latter. The numbers thus calculated clearly indicate that the molecular magnetic rotary power follows the chemical composition. Thus :—

	M. R. P.	Difference for CH_2 .
Water.. ..	1.00	
Methyl iodide	9.07	
Ethyl "	10.19	1.12
Propyl "	11.39	1.20
Amyl "	13.4	2.0
Methyl alcohol.. ..	1.62	
Ethyl "	2.68	1.06
Propyl "	3.74	1.06
Butyl "	4.88	1.14
Amyl "	6.00	1.12

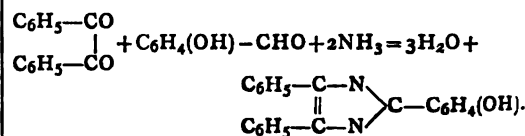
A specimen of amylen, C_5H_{10} , gave the number 5.7, which is very nearly 5.5 (5×1.1). Isomeric and metameric bodies show slight differences. The author promises further researches in the aromatic series, and as to the effect of isomerism.

Dr. MILLS was much interested in the paper, from a theoretical point of view. He would suggest the determination of the magnetic rotatory power of some of the higher members of the series. In several cases a value seemed to be indicated for CH_2 in the lower members of a series which was not confirmed by determinations made with the higher members of the series.

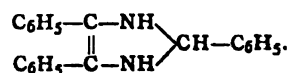
Dr. JAPP then read a paper "On the Constitution of Amarine and Lophine," by F. R. JAPP and H. H. ROBINSON. Amarine, $\text{C}_{21}\text{H}_{18}\text{N}_2$, was prepared by Laurent by saturating an alcoholic solution of benz-aldehyd with ammonia. Fownes prepared this substance by boiling the isomeric hydro-benzamide with caustic potash. Lophine, $\text{C}_{21}\text{H}_{16}\text{N}_2$, was obtained by Fownes by the destructive distillation of amarine, and by Laurent in the destructive distillation of hydro-benzamide. Fischer and Troschke (*Ber.*, 13, 706), from various considerations, assign to lophine the formula,



but state that the existing experimental material affords no safe criterion for the position of the last hydrogen atom, nor the arrangement of the remaining bonds in the ring. Now there is an unmistakable resemblance between the above partially-developed formula and the formulæ of the compounds recently obtained by one of the authors (in conjunction with W. Streatfield) by the action of hydroxy-aldehyds and ammonia upon phenanthraquinone. It appeared to the authors, therefore, that by the action of para-hydroxy-benzaldehyd on benzol in the presence of ammonia, hydroxylophin ought to be obtained by this equation :—

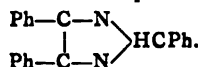


On trying this reaction, hydroxylophin was obtained, and by distillation with zinc-dust furnished lophine, identical in every respect with that obtained by Laurent, Fownes, &c. Lophine therefore belongs to the class of Hübner's anhydro-bases, and would be named anhydro-benzoyl-diamido-stilbene. The authors assign to amarine the formula—



The authors hope by extending the above reaction to prepare fresh analogues of lophine.

Dr. ARMSTRONG suggested another method of completing Fischer's formula for lophine—



Dr. JAPP could not agree with this formula, because, besides the introduction of dyad hydrogen and triad carbon, it did not explain the formation of the diethyl-lophinium iodide prepared by Kühn (*Ann.*, 122, 327).

After the thanks of the meeting had been given to the authors for their respective papers, the Society adjourned to June 1st, when a paper will be read "On the Spectroscopic Study of Chlorophyll," by Drs. Russell and Lapraik.

PHYSICAL SOCIETY.

Saturday, May 20th, 1882.

Professor FULLER in the Chair.

PROF. W. CHANDLER ROBERTS, F.R.S., communicated the results he had obtained in repeating the experiments of M. W. Spring, Professor at the University of Liège, on the union of finely-divided particles of metal by pressure. M. Spring had shown that at a pressure varying from 5000 to 7500 atmospheres, metallic filings may be united into coherent discs. Thus, at a pressure of 6000 atmospheres bismuth filings may be united into a disc, which has a crystalline fracture and a density which is identical with that of the metal cooled from the molten state. Zinc, again, also a very crystalline metal, will weld into a disc at a pressure of 7000 atmospheres, and the metal will even "flow" into cracks between the die and the collar surrounding it, just as in the experiments of M. Tresca, lead "flowed" under similar circumstances. Prof. Roberts had repeated and confirmed many of the experiments of M. Spring, whose more recent results are of special interest, as he has shown that if filings of bismuth, lead, and cadmium be mixed in suitable proportions—such, for instance, as in Wood's alloy—and if the mixture be submitted to a pressure of 7500 atmospheres, an alloy is obtained which will actually fuse at 70° C., the true fusing-point of Wood's alloy being 63° C. Prof. Roberts showed to the Society an alloy he had prepared which melted below 100° C., although of the constituent metals the lowest melting-point is 230° C., and he pointed out the great interest, both to the physicist and metallurgist, of M. Spring's results.

Mr. WALTER BAILY then showed mathematically that the repulsion between the magnet and revolving copper disc in the experiment shown by Prof. Guthrie at the last meeting of the Society, ought to vary as the square of the velocity of rotation of the disc, a result which Prof. Guthrie had found.

Mr. LECCKY gave the results of tests of Mr. Bennet's cell (described at the last meeting) made by Prof. Guthrie. The electromotive force was 1.14 volts, the internal resistance 0.8 ohm, but both quantities vary under certain conditions.

Prof. MACLEOD also gave the results of tests made by him. These show that the cell rose in E.M.F. from 1.005 volts on charging to 1.213 volts after standing three days. The internal resistance was then 1.007 ohms. Both quantities varied under different conditions of working.

Mr. C. V. BOYS then exhibited an improved form of his vibratory meter for measuring electric currents, and specially designed for electric lighting purposes. He has applied to the form formerly shown to the Society the contact-making device employed in Hipp's electric clocks, which though imperfectly adaptable to the clocks is perfectly adaptable to the meter. The force is proportional to the displacement. No sliding contacts are employed. Mr. Boys also explained some other plans for current

meters, one of which he believes to be the final form for practice, and which, besides being remarkably simple in construction, is free from the objection of being tampered with by means of extraneous magnets. In reply to Prof. Foster, he stated that self-induction does not disturb their action.

NOTICES OF BOOKS.

Foods: their Composition and Analysis. A Manual for the Use of Analytical Chemists and others. With an Introductory Essay on the History of Adulteration. By A. WYNTER BLYTH, M.R.C.S., F.C.S., &c. London: C. Griffin and Co.

THE work before us is a portion of the second edition of the author's "Manual of Practical Chemistry." The second, or toxicological portion, will appear separately under the title of "Poisons: their Effects and Detection." The present volume, though covering the same ground as the division "Foods" in the former edition, is substantially a new work. It has been thoroughly revised, enlarged, and in part re-written, and now forms an admirable digest of the most recent state of knowledge on the detection of the various impurities and sophistications to which articles of food are unfortunately liable.

Mr. Blyth opens his work with a history of adulterations, of the laws for their repression, and of the chemical and microscopical means for their recognition. There is a useful summary of the present English law on the subject, with its loopholes and the quibbles of which offenders or their legal advisers have availed themselves, too often with success.

An introductory chapter to Part II. is devoted to an account of certain special forms of apparatus used in food analysis, and not figured or described in the ordinary chemical manuals. Amongst these are Soxhlet's apparatus for treating substances with solvents; Clausnizer's modification of the same appliance for smaller quantities; the author's own arrangement for extraction with ether, petroleum, &c.; Jolly's spiral balance, and the exhausting apparatus used by the Swan Electric Light Company. The microscope, micro-chemical research, the micro-spectroscope, and micro-photography are next described. The detection of colouring matters as applied to articles of food and drink is very carefully discussed. The determination of the ash of organic matter is next considered, and several possible sources of error are pointed out.

After these preliminary instructions the author passes on to a systematic review of the various articles of food, the special frauds to which each is liable, and the best methods used for its detection. Under sugar he remarks that loaf sugar is, as a rule, chemically pure, and that the adulterations enumerated as occurring in raw sugars represent "more what is possible than what actually exists." There is reason, however, to fear that depraved ingenuity, stimulated by the necessity of finding a market for the ever-increasing production of starch-sugar, will find out novel means of incorporating this inferior product with saccharose. A comparative analysis given of the respective ashes of cane- and beet-sugars shows some interesting points. The ash of cane-sugar is poorer in alkaline matter, and shows merely 0.87 per cent of soda as against 11.12 per cent in beetroot-sugar. Under the colouring matters likely to be met with in sweetmeats we meet with one with which we are not acquainted, to wit, "saffron blue." We also find safflower classed among yellow colouring matters. Now although safflower does contain two yellow colouring principles, we never knew them put to any practical use, as better yellow colouring matters are abundant.

Honey is now very extensively forged, even to the extent of spurious combs made of paraffin. Mr. Blyth

recommends an examination of the comb with warm sulphuric acid, which attacks and blackens bees' wax, whilst it is without action upon paraffin. A microscopic examination of spurious honey shows the absence of grains of pollen.

Jams are pronounced, with truth, to be extensively adulterated. Indeed, there are said to be jams in the market which contain not a particle of fruit. The author recommends a microscopic examination of the tissues, seeds, &c., and a spectroscopic examination of the colouring matters.

Vogel's table for the diagnosis of starches is here inserted, and will be found exceedingly useful in determining a variety of vegetable bodies.

Under wheat we find mention of the important fact that a determination of its nitrogen by combustion by no means shows its comparative dietetic value, or, indeed, that of barley and oats, &c. Much of the nitrogen present in the outer layers of the grain does not occur as albumenoid matter, but as nitric and nitrous acids, and alkaloids not assimilable by the human system. Hence the movement for the use of bread made of the entire grain lacks a scientific basis.

Instructions are given for the detection of the seeds of corn-cockle (*Agrostemma cithago*), of darnel (*Lolium temulentum*), and of the ergot. These substances are, of course, never intentionally mixed with grain, but they may be accidentally present, and in case of unaccountable sickness breaking out among the consumers of some particular make of bread they should be sought for. A curious fact, not generally known, is that fresh bread contains on an average 0.313 per cent of alcohol, and that 0.132 to 0.120 per cent may be found even in samples a week old.

The "Farinaceous Foods," so commonly used as foods for young children, are rightly condemned as consisting mainly of starch and saccharine matter, which the child is unable to assimilate, and is in consequence literally starved. A medical friend informs us that he has been frequently consulted when the injury done in this manner has been irretrievable. Mr. Blyth rightly remarks that a child at the breast is more of a carnivorous than of an omnivorous animal, and will digest meat-broth, meat, and albuminous fluids with ease, whilst it is unable to assimilate the farinaceæ. The same rule holds good with many animal species. Thus most of our fruit- and grain-eating birds when in the nest require and receive a purely animal diet. It is to be regretted that the author makes no mention of the corn-flours which generally consist of the meal of some kind of grain deprived of its albumenoid, saccharine, and fatty matters—in other words, of its most valuable constituents—and yet finding a readier sale than the material of which it may be considered the inferior portion.

Mention is made of a peculiar poisonous principle sometimes developed in pears. In a case of this kind, which occurred some little time ago in Salford, many persons exhibited the symptoms of an irritant poison, though neither arsenic, copper, lead, &c., could be detected. The compound produced may possibly be analogous to the ptomaines.

Turning to milk, we find that the author's own experiments confirm the view of Wanklyn, Carter Bell, and others, that the true lowest percentage of milk solids, minus fat, is a little above rather than below 9. Mr. Blyth speaks here of a fact little known, that the pigeon for a little time after her young are hatched secretes in her crop a peculiar albuminous fluid, supposed to serve for the food of the nestlings. In determining the total solids of milk it appears that the results when platinum capsules are used are more constant and lower than in case of porcelain or glass vessels. Diseased milks, the author considers, can only be detected by biological methods. Milk, he states, contains all that is necessary for the nourishment and growth of disease-zymoids.

Space does not allow us to proceed further with our

examination of this excellent work. We can confidently recommend it to analytical chemists and to the medical profession, and even the educated part of the lay public will find in it much instructive and by no means unpleasant reading.

OBITUARY.

MR. DUGALD CAMPBELL.

MR. DUGALD CAMPBELL, of Quality Court, Chancery Lane, who has long been known as an analytical chemist, died at his house in Holland Road, Kensington, on the 12th inst., at the age of 64. Mr. Campbell was born in Scotland, and was connected with some of the best Scottish families. In his youth he went to Australia, and on his return to this country commenced the study of chemistry under Professor Graham, at University College, where he subsequently held the post of Demonstrator of Chemistry for a few years. Whilst filling that position he published (in 1869) his "Practical Text-book of Inorganic Chemistry," which enjoyed a considerable amount of repute in its day. Very early in his career he commenced to pay attention to the subject of water analysis, and he assisted Professor Clark, of Aberdeen, in his experiments on the process of water-purification, with which his name is associated. Mr. Campbell has long been regarded as a great authority on water, sewage, &c., and was largely consulted by sanitary authorities and the promoters of water-works. Although he never held any formal appointment under Government, he was frequently consulted by the Inland Revenue Department on questions of adulteration. Many years ago he undertook, in conjunction with Professor Graham and Dr. Stenhouse, an elaborate series of researches with reference to the adulteration of coffee, the results of which appeared in the Chemical Society's *Journal*, to which he also contributed papers "On the Application of Sewage to Agriculture," and "On the Source of the Water in the Deep Wells of the Chalk under London;" a short article "On the Presence of Arsenic in River Sand," in the *Philosophical Magazine*, and a paper "On the Effect of Magnesia on the Soap Test," which was read before the British Association in 1851, completes the number of his published researches, so far as we are aware. Some years ago he served on the Council of the Chemical Society, and he also belonged to the Council of the Institute of Chemistry. The appointment of Chemist to Brompton Hospital was also held by him. Mr. Campbell was entrusted by the Commissioners of Patents with the preparation of several volumes of their "Abridgments," amongst which may be mentioned those relating to "India-rubber and Gutta Percha," "Gas," "Medicine," "Oils, Fats, and Candles," "Acids, Alkalies, and Salts," and "Sugar." He was well known in the law courts as a scientific witness, and his analyses were made with so much care, and his evidence was given in such a cautious and guarded manner—in this respect he was a thorough Scotchman—that he was rarely shaken in cross examination. For many years, and up to the time of his death, he was largely indebted to the skill of his Assistant, Mr. H. R. Gregory. Mr. Campbell's health had been in a precarious state for some months, the proximate of his death being an attack of paralysis. He was buried at Brompton Cemetery on Tuesday last.

Researches on the Form in which Nitrogen is to be given to Crops.—Dr. E. Wien.—The plants experimented upon (oats, peas, broad beans, and soja beans) all prefer saltpetre to ammonia. The author recommends saltpetre as preferable to ammonium sulphate for mixing with phosphates.—*Biedermann's Centralblatt*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 18, May 1, 1882.

Certain Reactions of Mercuric Chloride.—H. Debray.—The author has for some time employed calomel for precipitating palladium and platinum in the metallic state from the solutions of their chlorides. The calomel passes into the condition of mercuric chloride, whilst iridium, ruthenium, and rhodium remain as sesquichlorides. The advantages or defects of this method of separating the platinum metals will be the subject of a future communication. The author at present merely points out certain reactions of mercuric chloride in presence of ammonium hydrochlorate or the alkaline chlorides. Mercuric chloride is known to be reduced to the insoluble mercurous salt by a solution of sulphurous acid. This reaction is accelerated by heat, and is very rapid at a temperature bordering upon ebullition. It is no longer the case if the solution contains an excess of sodium chloride (twenty times the weight of the mercuric chloride or upwards). On boiling and adding sulphurous acid to any extent, there is no precipitate of calomel. The hypothesis that mercuric chloride by combining with the alkaline chlorides is inadmissible, according to the recent thermo-chemical investigations of M. Berthelot. The precipitation of mercuric acid by potassa or soda in presence of a large excess of an alkaline chloride presents other interesting features. If a soluble alkali is poured little by little into a solution of mercuric chloride, there is formed a precipitate of variable colour, from yellow to black, especially on heating the liquor. This depends on the formation of oxychlorides, of compositions varying with the proportions of the soluble chloride and of the alkali employed. If the alkali is in excess, all the oxychlorides are destroyed, and we obtain the ordinary yellow precipitate of mercuric oxide. The presence of a large excess of sodium chloride hinders the production of these intermediate compounds. The addition of an alkali to such a solution does not cause an immediate precipitate, even if it is in excess, but after a few moments the oxide is deposited of a crystalline appearance, and more dense than that usually obtained by precipitation. If the liquids are cold, it is yellow, but if precipitated at the boiling-point it is red, approaching the oxide obtained by calcining the nitrate. Like the latter, the precipitated red oxide is not attacked by dry chlorine; the crystalline yellow oxide is slightly attacked by chlorine, but much more slowly than the ordinary amorphous oxide.

Use of Liquefied Gases and especially Ethylene for the Production of Low Temperatures.—L. Cailletet.—Liquefied ethylene boiling at the atmospheric pressure can produce a cold more intense than has been hitherto realised. It has, further, the property of remaining liquid and transparent at temperatures where nitrous oxide and carbonic acid become opaque. The author hopes that by condensing gases less easily liquefiable than ethylene, he may obtain still lower temperatures.

Separation of Gallium.—Lecoq de Boisbandran.—See p. 228.

Polarisation of Electrodes and Conductivity of Liquids.—E. Bouty.—Whatever is the electromotive force of the battery, the polarisation of each of the electrodes is at first inferior to any measurable quantity; it attains its limit in a few minutes at the negative electrode, where it is weaker, and only in some hours at the positive electrode, where it is stronger. In any case it is the result of the passage of a current, which traverses at first the voltameter with the full intensity determined by

the electromotive force and the resistance employed, but which grows progressively weaker as the alteration of the surfaces of contact of the electrodes and of the liquid gives rise to polarisation. A liquid has only one method of conducting electricity, whatever may be the particular phenomena of which the electrodes are the seat.

Influence of a Metal upon the Nature of the Surface of another Metal placed at a very Small Distance.—H. Pellat.—If two metallic surfaces are placed parallel to and at a little distance from each other (a few millimetres or a few tenths of a millimetre), each metal has generally undergone a slight change in the properties of its superficial layer, due to the neighbourhood of the other metal, and depending upon the nature of the latter. This change requires a few minutes for its production, increases with time, but tends towards a limit. When the influencing metal is removed, the one influenced returns by degrees and spontaneously to its original state. The phenomenon was detected by measuring the differences of potential that exist between the electric strata which cover the surfaces of two metals in contact. Amongst the influencing metals, lead and iron produce the most considerable effects; copper, gold, and platinum give a distinct effect; zinc does not appear to modify a metallic surface placed near it. The phenomenon observed, though detected and studied electrically, is not of an electric character. It is a purely material action depending essentially on the nature of the influencing metal, and being great with lead, less with copper, and *nil* with zinc. It appears as if metals gave off, at common temperatures, a volatile substance, which, when deposited upon the surface of objects, modifies their chemical nature. The author believes that this phenomenon approaches the images of Möser, and is connected with the fact that several metals have a slight odour.

Liquefaction of Ozone.—P. Hautefeuille and J. Chappuis.—The authors have obtained ozone in liquid drops of a deep indigo-blue; this liquid has been preserved for nearly thirty minutes under a pressure of 75 atmospheres, and its evaporation is not very rapid, even under the atmospheric pressure. The liquefaction was obtained by compressing a mixture of oxygen and ozone contained in the cylinder of M. Cailletet's apparatus.

Action of Insoluble Metallic Sulphides upon a Solution of Acid Nickel Sulphide in Presence of Sulphuretted Hydrogen.—H. Baubigny.—This memoir will be inserted at length.

Oxidation of Pyrogallol in Presence of Gum Arabic.—Ph. de Clermont and P. Chautard.—The authors, following the indications of H. Struve, obtain purpurogalline by causing aqueous solutions of gum arabic to react upon pyrogallol acid, likewise dissolved in water. They dissolve 10 grms. pyrogallol acid in a little water, and add to the solution 500 c.c. of a solution of gum at one-tenth. The whole is introduced into a wide flask containing 2 litres. In a few moments the mixture becomes pale yellow, and shortly afterwards brown. After some hours the purpurogalline begins to be precipitated; the deposit increases daily, and in two months the operation is terminated. They add then an excess of water to remove the gum; the precipitate is let settle, and washed several times by decantation, and then filtered. The purpurogallin is thus obtained in crystalline needles of a fine golden-yellow, which are freed from traces of gum by being dissolved two or three times in alcohol.

Chemical Study of Various Products of Uruguay.—M. Sacc.—The products in question are caoutchouc, the camphor tree, a vetch with blue flowers, and an *Alsine*.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 3.

Composition and Use of Peat Litter.—Prof. J. König.—Peat litter, *i. e.*, the fibrous upper layer of peat,

is poorer than straw in potash, phosphoric acid, and lime, but richer in nitrogen. Their agricultural value is about equal. The peat has a greater power of retaining ammonia.

Grandeau's Theory on the Fertility of Soils applied to Different Soils, with Especial Reference to their Valuation.—C. F. A. Tuxen.—The author comes to the conclusion that Grandeau's theory, though it enables us to recognise important relations in the soil, does not possess the universal validity needed for ascertaining the fertility of the soil. Neither the determination of the *matière noire* nor that of its phosphoric acid gave results from which conclusions could be formed as to the fertility of the samples.

The Utilisation of the Residue of Molasses and the Products formed on its Dry Distillation.—MM. Ernst, Brosche, Oppermann, &c.—The products obtained are potash, ammonium sulphate, methylic alcohol, tarry oils, and resin.

Reverted Nitrogen.—H. Pellet.—Of the nitrogen of dried blood about 50 per cent is soluble in water, but only small quantities of that present in powdered leather. The degree of solubility of the nitrogen present in a manurial agent may give a standard for its agricultural value. On treating wool, silk, &c., with steam under pressure, and evaporating the liquid, there is obtained a manure, azotine,—a matter containing from 11 to 14 per cent of nitrogen, completely soluble in water. If mixed with superphosphate the nitrogen becomes insoluble.

Experiments with Phosphoric Acid in Different Forms.—Prof. Krockner and Dr. H. Grahl.—Bone-dust in conjunction with ammonium sulphate gave the highest result. Precipitated phosphoric acid, whether with or without ammonium sulphate, gave better results than either reverted or soluble phosphoric acid under the same conditions.

Manuring with Kainite or Moorland Meadow.—Prof. M. Maercker.—Of the mixtures tried, 1 part superphosphate with 3 parts kainite was the only one which proved remunerative.

Journal de Pharmacie et de Chimie.
May, 1882.

"Disinfection" of Commercial Alcohol.—A. Riche.—This memoir has been going the round of the press, and has been already noticed in the CHEMICAL NEWS.

New Researches on the Water of Schinznach.—MM. Oberlin and Schlagdenhauffen.—A paper of specially pharmaceutical interest.

Detection of "Denaturated" Alcohol.—P. Cazeneuve.—The author uses potassium permanganate, which reacts upon the acetone invariably present in methylated spirit.

Note on the Tincture of Iodine.—J. Castelhaaz.—The author adds potassium iodate to prevent the gradual alteration of this tincture.

The Best Process for Determining the Cinchona Alkaloids.—Dr. J. E. de Vrij.—The author recommends the process of Prollius, which consists in the use of the following liquid for extracting the bark:—Ether, 88 parts; liquid ammonia, 4 parts; alcohol, at 92° to 96° per cent, 8 parts.

Production of Carbon Oxy-chloride in Chloroform.—J. Regnaud.—Carbon oxy-chloride which results from the decomposition of chloroform exposed to the air and the sun's rays is the most dangerous impurity in this anæsthetic. It is produced when a mixture of the vapour of chloroform and of air is exposed to the sparks of a Ruhmkorff's coil, or to the effluve, or when the vapour of chloroform comes in contact with ozonised air.

Safety-tube for Gas Generators.—F. Bellamy.—The apparatus cannot be described intelligibly without the accompanying figures.

Detection of Iron in Urine.—M. Quillart.—The author destroys the organic matter by means of pure sulphuric acid. The ash, when cold, is treated with nitric acid to peroxidise the iron. It is then evaporated to dryness at a gentle heat; the residue is taken up with distilled water acidulated with a drop of nitric acid, and the liquid thus obtained is treated with the ordinary reagents for iron.

Rouge Végétal.—MM. Guichard and C. Thomas.—Rouge végétal, or Rouge de Bordeaux, is a colour much used in sophisticating wines. It is an azo-dye, the so-called Bordeaux manufactured by the Hoechst Aniline Works. M. Thomas, to detect this colour, dyes silk with the wine. A genuine red wine dyes silk a violet or lilac, which, on the addition of a few drops of ammonia, takes a greenish tint. Wines coloured with Rouge végétal dye silk a garnet red, which is darkened by ammonia and turned more to a brown. As a further test, he drops a portion of the wine upon chalk moistened with solution of alum. Natural wines stain the chalk a violet-grey; wines coloured with the dye in question give decided red spots.

MEETINGS FOR THE WEEK.

- TUESDAY, 30th.—Institute of Civil Engineers, 8.
Royal Institution, 3. "Digestion," by Professor A. Gamgee.
WEDNESDAY, 31st.—Society of Arts, 8.
THURSDAY, June 1st.—Royal Institution, 3. "The Metals," by Prof. Dewar.
Royal Society Club, 6.30.
Chemical, 8. "Spectroscopic Study of Chlorophyll," Drs. Lapraik and Russell.
FRIDAY, 2nd.—Royal Institution, 8. "The Intellectual Basis of Music," by Mr. H. H. Statham, at 9.
SATURDAY, 3rd.—Royal Institution, 3. "Poetry and its Literary Forms," Professor D. Masson.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1175.

ON THE CAUSE OF THE LIGHT BORDER FREQUENTLY NOTICED IN PHOTOGRAPHS JUST OUTSIDE THE OUTLINE OF A DARK BODY SEEN AGAINST THE SKY;

WITH SOME INTRODUCTORY REMARKS ON
PHOSPHORESCENCE.*

By PROFESSOR G. G. STOKES, Sec. R.S.

AN observation I made the other day with solar phosphori, though not involving anything new in principle, suggested to me an explanation of the above phenomenon which seems to me very likely to be the true one. On inquiring from Captain Abney whether it had already been explained, he wrote: "The usual explanation of the phenomenon you describe is that the silver solution on the part of the plate on which the dark objects fall has nowhere to deposit, and hence the metallic silver is deposited to the nearest part strongly acted upon by light." As this explanation seems to me to involve some difficulties, I venture to offer another.

1. I will first mention the suggestive experiment, which is not wholly uninteresting on its own account, as affording a pretty illustration of what is already known, and furnishing an easy and rapid mode of determining in a rough way the character of the absorption of media for rays of low refrangibility.

The sun's light is reflected horizontally into a darkened room, and passed through a lens,† of considerable aperture for its focal length. A phosphorus is taken, suppose sulphide of calcium giving out a deep blue light,‡ and a position chosen for it which may be varied at pleasure, but which I will suppose to be nearer to the lens than its principal focus, at a place where a section of the pencil passing through the lens by a plane perpendicular to its axis shows the caustic surface well developed. A screen is then placed to intercept the pencil passing through the lens, and the phosphorus is exposed to sunlight or diffuse daylight, so as to be uniformly luminous, and is then placed in position; the screen is then removed for a very short time and then replaced, and the effect on the phosphorus is observed.

Under the circumstances described there is seen a circular disk of blue light, much brighter than the general ground, where the excitement of the phosphorus has been refreshed. This is separated by a dark halo from the general ground, which shines by virtue of the original excitement, not having been touched by the rays which came through the lens.

2. The halo is due to the action of the less refrangible rays, which, as is well known, discharge the phosphorescence. Their first effect, as is also known, is, however, to cause the phosphorus to give out light; and if the exposure were very brief, or else the intensity of the discharging rays were sufficiently reduced, the part where they acted was seen to glow with a greenish light, which faded much more rapidly than the deep blue, so that after a short time it became relatively dark.

3. This change of colour of the phosphorescent light

can hardly fail to have been noticed, but I have not seen mention of it. In this respect the effect of the admission of the discharging rays is quite different from that of warming the phosphorus, which as is known causes the phosphorus to be brighter for a time, and then to cease phosphorescing till it is excited afresh. The difference is one which it seems important to bear in mind in relation to theory. Warming the phosphorus seems to set the molecules more free to execute vibrations of the same character as those produced by the action of the rays of high refrangibility. But the action of the discharging rays changes the character of the molecular vibrations, converting them into others having on the whole a lower refrangibility, and being much less lasting.

4. Accordingly when the phosphorus is acted on simultaneously by light containing rays of various refrangibilities, the tint of the resulting phosphorescence, and its more or less lasting character, depend materially on the proportion between the exciting and discharging rays emanating from the source of light. Thus daylight gives a bluer and more lasting phosphorescence than gaslight or lamplight. I took a tablet which had been exposed to the evening light, and had got rather faint, and, covering half of it with a book, I exposed the other half to gaslight. On carrying it into the dark, the freshly exposed half was seen to be much the brighter, the light being, however, whitish, but after some considerable time the unexposed half was the brighter of the two.

Again, on exposing a tablet, in one part covered with a glass vessel containing a solution of ammonio-sulphate of copper, to the radiation from a gas flame, the covered part was seen to be decidedly bluer than the rest; the phosphorescence of which was whitish. The former part, usually brighter at first than the rest, was sure to be so after a very little time. The reason of this is plain after what precedes.

A solution of chromate of potash is particularly well suited for a ray filter when the object is to discharge the phosphorescence of sulphide of calcium. While it stops the exciting rays it is transparent for nearly the whole of the discharging rays. The phosphorescence is accordingly a good deal more quickly discharged under such a solution than under red glass, which along with the exciting rays absorbs also a much larger proportion than the chromate of the discharging rays.

5. I will mention only one instance of the application of this arrangement to the study of absorption. On placing before excited sulphide of calcium a plate of ebonite given me by Mr. Preece as a specimen of the transparent kind for certain rays of low refrangibility, and then removing the intercepting screen from the lens, the transmission of a radiation through the ebonite was immediately shewn by the production of the greenish light above-mentioned. Of course, after a sufficient time the part acted on became dark.

6. I will mention two more observations as leading on to the explanation of the photographic phenomenon which I have to suggest.

In a dark room, an image of the flame of a paraffin lamp was thrown by a lens on to a phosphorescent tablet. On intercepting the incident rays after no great exposure of the tablet, the place of the image was naturally seen to be luminous, with a bluish light. On forming in a similar manner an image of an aperture in the window shutter, illuminated by the light of an overcast sky reflected horizontally by a looking-glass outside, this image of course was luminous; it was brighter than the other. On now allowing both lights to act simultaneously on the tablet, the image of the flame being arranged to fall in the middle of the larger image of the aperture, and after a suitable exposure cutting off both lights simultaneously, the place of the image of the aperture on which the image of the lamp had fallen was seen to be less luminous than the remainder, which had been excited by daylight alone. The reason is plain. The proportion of rays of lower to rays of higher refrangibility is much greater in lamplight

* A Paper read before the Royal Society, May 25th, 1882.

† The lens actually used was one of crown glass which I happened to have; a lens of flint glass would have been better, as giving more separation of the caustic surfaces for the different colours.

‡ The experiments were actually made, partly with a tablet painted with Balmann's luminous paint, partly with sulphide of calcium and other phosphori in powder.

than in the light of the sky; so that the addition of the lamplight did more harm by the action of the discharging rays which it contained on the phosphorescence produced by the daylight, than it can do good by its own contribution to the phosphorescence.

7. The other observation was as follows:—The same tablet was laid horizontally on a lawn on a bright day towards evening, when the sun was moderately low, and a pole was stuck in the grass in front of it, so as to cast a shadow on the tablet. After a brief exposure the tablet was covered with a dark cloth, and carried into a dark room for examination.

It was found that the place of the shadow was brighter than the general ground, and also a deeper blue. For a short distance on both sides of the shadow the phosphorescence was a little feebler than at a greater distance.

This shows that, though the direct rays of the sun by themselves alone would have strongly excited the phosphorus, yet acting along with the diffused light from all parts of the sky, they did more harm than good. They behaved, in fact, like the rays from the lamp in the experiment of § 6. The slightly inferior luminosity of the parts to some little distance on both sides of that on which the shadow fell, shows that the loss of the diffuse light corresponding to the portion of the sky cut off by the pole was quite sensible when that portion lay very near the sun.

All this falls in very well with what we know of the nature of the direct sunlight and the light from the sky. In passing through the atmosphere, the direct rays of the sun get obstructed by very minute particles of dust, globules of water forming a haze too tenuous to be noticed, &c. The veil is virtually coarser for blue than for red light, so that in the unimpeded light the proportion of the rays of low to those of high refrangibility goes on continually increasing, the effect by the time the rays reach the earth increasing as the sun gets lower, and has accordingly a greater stretch of air to get through. Of the light falling upon the obstructing particles, a portion might be absorbed in the case of particles of very opaque substances, but usually there would be little loss this way, and the greater part would be diffused by reflection and diffraction. This diffused light, in which there is a predominance of the rays of higher refrangibility, would naturally be strongest in directions not very far from that of the direct light; and the loss accordingly of a portion of it where it is strongest, in consequence of interception by the pole in front of the tablet, accounts for the fact that the borders of the place of the shadow were seen to be a little less luminous than the parts at a distance.

8. The observations on phosphorescence just described have now prepared the way for the explanation I have to suggest of the photographic phenomenon.

It is known that, with certain preparations, if a plate be exposed for a very short time to diffuse daylight, and be then exposed to a pure spectrum in a dark room, on subsequently developing the image it is found that while the more refrangible rays have acted positively, that is, in the manner of light in general, a certain portion of the less refrangible have acted in an opposite way, having undone the action of the diffuse daylight to which the plate was exposed in the first instance.

It appears, then, that in photography, as in phosphorescence, there may in certain cases be an antagonistic action between the more and less refrangible rays, so that it stands to reason that the withdrawal of the latter might promote the effect of the former.

Now the objective of a photographic camera is ordinarily chemically corrected; that is to say, the minimum focal length is made to lie, not in the brightest part of the spectrum, as in a telescope, but in the part which has strongest chemical action. What this is depends more or less on the particular substance acted on; but taking the preparations most usually employed, it may be said to lie about the indigo or violet. Such an objective would be much under-corrected for the red, which accordingly would be much out of focus, and the ultra-red still more so.

When such a camera is directed to a uniform bright object, such as a portion of overcast sky, the proportion of the rays of different refrangibilities to one another is just the same as if all the colours were in focus together; but it is otherwise near the edge of a dark object on a light ground. As regards the rays in focus, there is a sharp transition from light to dark; but as regards rays out of focus, the transition from light to dark though rapid is continuous. It is, of course, more nearly abrupt the more nearly the rays are in focus. Just at the outline of the object there would be half illumination as regards the rays out of focus. On receding from the outline on the bright side, the illumination would go on increasing, until on getting to a distance equal to the radius of the circle of diffusion (from being out of focus) of the particular colour under consideration the full intensity would be reached. Suppose, now, that on the sensitive plate the rays of low refrangibility tend to oppose the action of those of high refrangibility, or say act negatively, then just outside the outline the active rays, being sharply in focus, are in full force, but the negative rays have not yet acquired their full intensity. At an equal distance from the outline on the dark side the positive rays are absent, and the negative rays have nothing to oppose, and therefore simply do nothing.

9. I am well aware that this explanation has need of being confronted with experiment. But not being myself used to photographic manipulation, I was unwilling to spend time in attempting to do what could so much better be done by others. I will, therefore, merely indicate briefly what the theory would lead us to expect.

We might expect, therefore, that the formation of the fringe of extra brightness would depend:—

(1.) Very materially upon the chemical preparation employed. Those which most strongly exhibit the negative effect on exposure to a spectrum after a brief exposure to diffuse light might be expected to show it the most strongly.

(2.) Upon the character of the light. If the light of the bright ground be somewhat yellowish, indicating a deficiency in the more refrangible rays, the antagonistic effect would seem likely to be more strongly developed, and, therefore, the phenomenon might be expected to be more pronounced.

(3.) To a certain extent on the correction of the objective of the camera. An objective which was strictly chemically corrected might be expected to show the effect better than one in which the chemical and optical foci were made to coincide, and much better than one which was corrected for the visual rays.

It is needless to say that on any theory the light must not be too bright or the exposure too long; for we cannot have the exhibition (in the positive) of a brighter border to a ground which is white already.

P.S.—Before presenting the above paper to the Royal Society I submitted it to Captain Abney, as one of the highest authorities in scientific photography, asking whether he knew of anything to disprove the suggested explanation. He replied that he thought the explanation a possible one, encouraged me to present the paper, and kindly expressed the intention of submitting the question to the test of experiment.

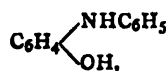
Photo-chemical Reaction of Iron Peroxalate.—M. Jodin.—The photo-chemical sensitiveness of oxalo-ferric solutions varies considerably with their composition. If we take a solution containing per litre $\frac{1}{2}$ mol. of ferric chloride and $\frac{1}{2}$ mol. of oxalic acid, and compare it with a solution containing 3 mols. of each, the photo-chemical sensitiveness of the former is five or six times greater than that of the second. This decrease of sensitiveness with increasing concentration seems connected with a certain complexity of the photo-chemical and photo-thermic properties of ferric chloride.—*Comptes Rendus*.

ON THE TRANSFORMATION OF PHENOLS
AND ALCOHOLS INTO AMINES.

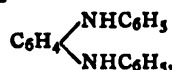
By V. MERZ.

Merz and Weith have previously shown (*Berl. Ber.*, xiv., p. 2343) that a mixture of resorcinol with the compound of aniline and calcium chloride, on sufficient heating, furnishes large quantities of meta-oxy-diphenylamine. But according to more recent experiments made in their laboratory by Dr. Calm, the presence of a dehydrating substance is not necessary for starting the reaction: meta-oxy-diphenylamine is, indeed, already formed by simply heating for some time resorcinol and aniline up to 300°; but the yield is moderate.

In similar circumstances hydroquinone is much more easily acted upon by aniline than is resorcinol. In this case, besides para-oxy-diphenylamine,—

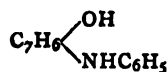


also the diamine,—



is formed. The former compound is easily soluble in alkaline liquids, also in dilute hot mineral acids; the latter is insoluble in alkaline liquids, and but sparingly so in dilute mineral acids, so that they can be separated without difficulty. Para-oxy-diphenylamine is very sparingly soluble in cold water, moderately so in hot water, not much more in petroleum spirit, but easily in benzene, alcohol, and ether. From the hot solution in petroleum spirit the oxy-compound crystallises in brilliantly shining scales; it fuses at 68.5° to 69°, and distils unchanged. The diamine is not soluble in water; easily so in alcohol, ether, and benzene, but sparingly even in hot petroleum spirit. But first from this solution it crystallises especially well in white brilliant laminæ, fusing at 152°. Both amines give colour reactions.

Mr. Buch has found (in the same laboratory) that on heating orcinol with aniline-calcium chloride the compound—

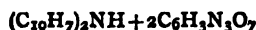


is formed in large quantities. Here also the reaction partly goes beyond the monamine. Oxy-tolyl-phenylamine crystallises from hot petroleum spirit, or from a large quantity of water, in shining scales, fusing at 79°.

A mixture of α -naphthol, β -naphthylamine, and calcium chloride has been found by Mr. Benz to furnish no mixed dinaphthylamine, but essentially only β -dinaphthylamine. But $\alpha\beta$ -dinaphthylamine is formed on heating β -naphthol, α -naphthylamine, and calcium chloride in considerable quantities. It crystallises from a mixture of alcohol and ether, either in flat or in thick prisms of glassy lustre; it fuses at 110° to 111°. Its acetyl derivative,—



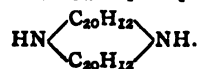
crystallises from alcohol in thick needles, fusing at 124.5° to 125°. The picric acid compound,—



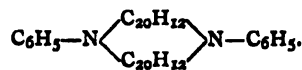
is sparingly soluble; it forms brownish black, shining needles, and fuses at 172° to 173°.

Dr. Walder has examined the behaviour of β -dinaphthol, which is now easily prepared, towards the zinc chloride compounds of ammonia and aniline. The reactions here take place with much more difficulty than with uncon-
densed naphthols; the temperature must be raised to 300°.

Ammonia-zinc chloride* and β -dinaphthol furnish a well-crystallising substance, $\text{C}_{20}\text{H}_{13}\text{N}$, which formula can be interpreted $\text{HN}=\text{C}_{20}\text{H}_{12}$, or perhaps rather—

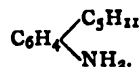


It crystallises from a mixture of benzene and petroleum spirit in cuneiform crystals; from a mixture of ether and alcohol, in colourless, shining needles. It is easily soluble in benzene and ether, sparingly so in alcohol, fuses at 157°, and is carbonised at a higher temperature. By heating it with acetyl chloride on the water-bath only a mono-substitution derivative, $\text{C}_{20}\text{H}_{12}(\text{C}_2\text{H}_3\text{O})\text{N}$, is formed, which crystallises in white needles, and fuses at 144°. The picric acid compound, $\text{C}_{20}\text{H}_{13}\text{N} + 2\text{C}_6\text{H}_3\text{N}_3\text{O}_7$, forms small, shining, black needles; it is sparingly soluble, and fuses at 216° to 217°. The product of the reaction of β -dinaphthol and aniline-zinc chloride crystallises from hot benzene alcohol or ether alcohol in vividly shining needles or prisms, fusing at 144°. Their analysis seems to prove the formula $\text{C}_{26}\text{H}_{17}\text{N}$, that is, $\text{C}_6\text{H}_5-\text{N}=\text{C}_{20}\text{H}_{12}$, or more probably—



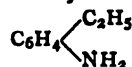
This would be a tertiary amide. In fact the substance was not acted upon by acetyl chloride under ordinary circumstances. Its solubility is similar to that of the amine from β -dinaphthol and ammonia-zinc chloride. It furnishes with picric acid a compound crystallising from hot benzene in brownish red needles, $\text{C}_{26}\text{H}_{17}\text{N} + 2\text{C}_6\text{H}_3\text{N}_3\text{O}_7$, fusing at 169°.

It is well known that amylic alcohol and aniline-zinc chloride, on heating, do not produce amyl-aniline, but a primary amine,—

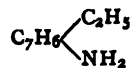


Exactly the same reaction with aniline-zinc chloride takes place with other alcohols of the ethylic series, perhaps even of other series.

Mr. Benz on heating absolute alcohol with aniline-zinc chloride to 260° to 280°, obtained, as principal products, a large quantity of amido-ethyl benzene,—

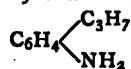


the boiling point (about 214°), the very slight solubility of the sulphate, and the fusing-point of its acetyl-derivative (94.5° to 95°) prove its identity with the already known para-ethyl-amido-benzene. Also the preparation of ethylamidotoluene,—



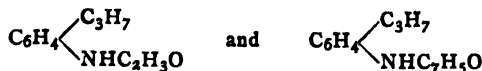
from orthotoluidine-zinc chloride and alcohol offers no difficulties. This base is oily, almost colourless, and boils about 230°. Its sulphate, and especially its oxalate, is very slightly soluble in pure cold water. The acetyl derivative crystallises, like that of amido-ethyl-benzene, in very fine, long, white, shining needles and fuses at 105 to 105.5°.

Mr. Louis found that on heating propylic alcohol with aniline-zinc chloride there is formed, as principal product, a considerable quantity of amido-propyl benzene,—

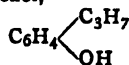


* When zinc chloride alone acts upon β -dinaphthol a dinaphthylene oxide is formed which is very similar to, but not identical with, the derivative of ordinary β -naphthol. The oxidation of β -dinaphthol in alkaline solution by potassium permanganate furnishes no phthalic acid, but a well-crystallising acid, $\text{C}_{18}\text{H}_{10}\text{O}_4$, whose examination is in progress.

Isopropyl alcohol furnishes amido-isopropyl benzene. Both amines are colourless oils: the propyl base distils at 224° to 226°, the isopropyl base at 216° to 217°. They form well-crystallising salts; their sulphates are but slightly soluble in cold water, that of the iso-base even in hot water. The acetyl and the benzoyl derivative of the propyl compound—



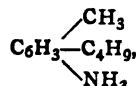
crystallise in pretty white scales; the former fuses at 87°, the latter at 115°. The amido-propyl-benzene was, with intermediate preparation of a diazo-compound, transformed into a phenol,—



which is an aromatic-smelling oil, boiling regularly between 227° and 228°.

On heating isobutylic alcohol with aniline-zinc chloride, or with aniline and phosphorus pentoxide, there was formed an amido-isobutyl-benzene, which is identical with that prepared by Huder from aniline hydrochlorate and isobutylic alcohol.

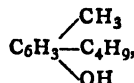
Mr. Erhardt on heating isobutylic alcohol with orthotoluidine-zinc-chloride obtained an oily amido-isobutyl-toluene,—



boiling at 234° to 236°. Here, also, the sulphate is but slightly soluble and thus lends itself for preparing the base in the pure state. The acetyl and benzoyl compound—



both crystallise from alcohol in white scales of silvery lustre; the former fused rather slowly at 138° to 141°, the latter sharply at 142°. The base can be transformed by a well-known process into a phenol, viz., isobutylic ortho-cresol—



and that perfectly smoothly. The new cresol is a colourless oil of very pleasant smell, boiling constantly at 235°.

Further researches will show whether the above-mentioned amines contain the introduced alcoholic radicle always in the para-position towards the amido-group, as is certain for amido-ethyl benzene, or if other positions may also occur. It is remarkable that paratoluidine, as far as can be inferred from its behaviour towards isobutylic alcohol, enters much less easily into reactions with alcohols than its isomer, orthotoluidine, where the para-position is still free.

Depression of the Zero-point in Mercurial Thermometers.—J. M. Crafts.—The author refers to the known fact that a thermometer which has remained for a long time at common temperatures exhibits a depression of its zero-point when heated. M. Pernet has shown that between 0° and 100° the depressions are proportionate to the squares of the temperatures. At higher temperatures M. Mills has found a different law. The values obtained by this observer resemble those found with thermometers which have not undergone a suitable preparation, and differ greatly from the results obtained by the author. For the details we must refer to the original paper.—*Comptes Rendus*, vol. 94, No. 19.

THE PTOMAINES AND THEIR SIGNIFICANCE IN JUDICIAL AND TOXICOLOGICAL CHEMISTRY.*

By Prof. TH. HUSEMANN.

WHEN the formation of ptomaines is particularly frequent in corpses which have been subjected to a slow process of decomposition, it is to be presumed that the same will be not unfrequently observed in the cadavers of persons which have been destroyed by acute arsenical poisoning. To such a probability Selmi had already pointed; but it was only some years later that he succeeded in furnishing the proof that peculiar bases are here in question, which contain arsenic, and which deviate in their properties from the hitherto known arsines. It will not appear strange that these cadaver bases containing arsenic possess a strongly poisonous action, as is indeed the case with the various artificially prepared arsines.

Selmi† had already in 1878 reported two cases in which strongly poisonous and crystalline ptomaines were found by him in exhumed bodies containing arsenic. In the first case the subject was that of a corpse exhumed fourteen days after burial, which appeared well preserved, and in which a large amount of arsenic was detected. By the search for alkaloids with ether in the liquid made alkaline with baryta, a small quantity of a substance having an alkaline reaction and a sharp and bitter taste was found. It crystallised readily in needles, gave with acids crystallisable salts, and precipitates with the principal alkaloidal reagents, but not with platonic chloride, with which a precipitate was only obtained in very concentrated solution. With sulphuric acid this ptomaine gave a reddish colouration; with iodic acid, and afterward with sulphuric acid, free iodine was liberated and a violet colouration produced, which completely disappeared by neutralisation with sodium bicarbonate; nitric acid coloured it beautifully yellow, and by saturation with caustic potassa this colour appeared still more perceptible; sulphuric acid containing nitric acid produced only after some time a reddish colouration; iodine in hydriodic acid gave no crystalline product. The amount of material did not suffice for a more complete chemical and physiological examination.

A short time afterwards Selmi succeeded in obtaining larger amounts of a more readily crystallisable ptomaine from a body containing arsenic, which had been exhumed one month after death. For obtaining the same the liquid obtained by extracting with aqueous alcohol was concentrated at from 35° to 45° C. to 70 c.c., then made alkaline with baryta, and shaken with ether. After the separation of the ether by distillation and spontaneous evaporation, there remained 5 c.c. of a turbid and somewhat coloured aqueous liquid, having an alkaline reaction, and a sharp, somewhat bitter taste. After the addition of a little water containing acetic acid, with which the retort used in distilling was washed, filtration, and evaporation to dryness at a moderate temperature, the residue was taken up with water, whereby a little colouring matter remained undissolved, the solution made alkaline with a little baryta, and the extraction with ether repeated. By the treatment of the alkaloid, which was thus obtained nearly colourless, with water containing acetic acid, evaporating to dryness, and again dissolving, a colourless solution was finally obtained, which showed the following behaviour towards alkaloidal reagents:—

Tannic acid, a white permanent precipitate.

Iodine in hydriodic acid, a kermes-brown precipitate, gradually disappearing, and furnishing microscopical colourless and branched, but no yellow or brown, crystals.

Platonic chloride, no precipitate, but in the course of

* Translated from *Archiv. der Pharm.*, xvi, December, 1881, pp. 415-424, by Fred. B. Power.

† *Atti della R. Accad. dei Lincei*, ser. 3, vol. 2, 1878.

containing nickel and cobalt is almost entirely decolourised, whilst the other still contains black flocks in suspension. If a small quantity of potassium cyanide is used, it is always possible to separate a quantity of nickel sufficient for recognition.—*Zeitschrift für Analytische Chemie.*

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, April 4, 1882.

R. ANGUS SMITH, Ph.D., F.R.S., &c., in the Chair.

"On the Occurrence of Oxide of Manganese (Wad) in the Yoredale Rocks of East Cheshire," by ARTHUR SMITH WOODWARD, Student of Owens College. Communicated by Dr. CHARLES A. BURGHARDT.

I. Introduction.

One of the most noticeable geological features of the eastern part of Cheshire is the enormous fracture forming the boundary between the carboniferous and new red sandstone formations, and known as the Red Rock Fault. This fault has a direction N.E. and S.W., and, according to the *Memoirs of the Geological Survey*, extends from a little to the N. of Stockport to Talk o' th' Hill, in Staffordshire, a distance of about 30 miles. In the more northern part of its course superficial evidence of its existence is either exceedingly scanty or entirely wanting, owing to the thickness of the glacial drift deposits which characterise the district through which it passes; but as it approaches Macclesfield there are slight indications at the surface of its presence, and as it continues south of this town the superficial evidence gradually becomes greater and more definite. Here there are considerable eminences on the western side of it, consisting of triassic strata not obscured by glacial drift; and hence the fault itself becomes visible at the surface.

Between Poynton and a locality about 3 miles south of Macclesfield it is bounded on its eastern side by the carboniferous formations in succession,—the two lower divisions of the coal-measures being most northern, next five divisions of the millstone grits, and below these, more to the south, the Yoredale Rocks; and it is in the latter rocks that the greatest amount of disturbance has arisen from it, in consequence of the fact that they are constituted not of thick, compact masses of sandstone, but of comparatively thin beds alternating with bands of shale. In this locality, in and around Ratcliffe Wood, there is a large number of sections, both natural and artificial, extending for several hundred yards to the eastern side of the fault, and after examining them, and taking note of the dip in each case, it is easily seen that the greatest confusion exists among the strata: small faults are very numerous, and often prove themselves to be great obstacles to the quarrying operations there carried on; and contortions of the beds, varying from only 2 or 3 feet to several yards in extent, abound in all directions. It is in the fissures produced by the disturbance of the beds in this locality that the mineral which I intend to describe in this paper is found.

II. Description of Section.

The quarrying at Ratcliffe Wood is carried on chiefly in tunnels, formed by the excavation of the beds of rock which are best adapted for the purposes to which the stone is applied, namely, repairing and making roads. Some months ago the quarrymen met with a fault which cut off the bed of rock that they were following, and in attempting to find again this lost stratum on the other side of the hill they opened a section nearer to the Red Rock Fault; and

it was here that I first noticed the oxide of manganese, early in December last.

This is the nearest section to the fault now exposed in that locality,—with the exception of comparatively unimportant exposures in the brooks running through the wood,—and is probably not more than 30 or 40 yards from it. As this is a very interesting section, apart from its mineral characteristics, since it shows the effect of the force exerted during the production of the great fault, a somewhat brief description of it may, perhaps, be not out of place at this point.

The principal opening is about 30 feet in length and 20 feet in height, but from the other small sections around it many more details of the stratification can be obtained. The direction of all these sections is nearly at right angles to the fault, namely, E. and W.

The lowest bed exposed consists of variegated soft shale, in small flakes (dip 59° — 10° E. of N.); above this is a stratum of sandstone, 5 feet in thickness, containing abundance of MnO_2 in the many fissures which traverse it, and it is a noticeable fact that in the lower portion of the section there is a larger quantity of the mineral than in the upper portion; next is a bed of variegated soft shale, 7 feet in thickness, in flakes, and similar in nature to the bed underlying the sandstone previously mentioned: the remainder of the section consists of alternating bands of shale and sandstone, much broken and contorted, and 14 feet thick, which gradually become more and more bent until they reach a position nearly 5 feet above the underlying bed of shale, when a stratum of sandstone, 8 inches thick, undergoes three decided bends,—in one case a complete break. This sandstone, like all the other beds in the section, has been shattered into small angular fragments, and into the cracks thus formed mineral matter has been introduced by the percolation of water. Many of the smaller fragments have again been cemented together by oxide of iron, as the cracks surrounding them had not separated the adjoining portions of rock far asunder, while the walls of the larger fissures are only coated with oxide of iron and argillaceous matter, or, in the upper part of the section, with oxide of manganese, and are not firmly united together.

Above this contorted bed of sandstone the alternating layers of rock are similarly disturbed for a thickness of about 7 feet, when the arrangement of the beds becomes very obscure, and a little above this the series assumes a nearly vertical dip.

The general appearance of the section shows that the contortions of the series have been produced by a slip, most probably at the time when the Red Rock Fault was formed. This is evident not only from the disturbed beds lying between two series, which have been very little bent, but also from the peculiar appearance of the layer of shale beneath, and the confused mass of broken sandstone above. In the underlying shale there are two or three very thin seams of carbonaceous matter, which are rendered rather conspicuous by their dark colour: these are curiously contorted, having been completely twisted in no less than four places, the interior of the folds being occupied by confused masses of variously coloured crushed shale.

III. Occurrence and Properties of the MnO_2 .

The most typical specimens of oxide of manganese (wad) are to be obtained from the fissures in the lower bed of sandstone in the section just described. Here it occurs in considerable quantity, and is in a very accessible place. The walls of the cavities produced by the fissuring of the rock are covered with a layer of the mineral, never more than $\frac{1}{2}$ inch in thickness, which is not at all smooth on the exterior, but has the appearance of soot adhering to the side of a chimney: this form is caused by a pellet-like structure assumed by the substance. The layer appears to cover all the walls of the cavities equally, not becoming perceptibly thicker on the lower sides, and not altering in appearance in different parts.

But the most peculiar and characteristic feature of the

wad in this sandstone is its occurrence in miniature columns, joining the two opposite walls of the cavities, and in long slender threads, stretching in all directions over the rough surface of the mineral incrustation. So far as I have been able to ascertain, none of these columns or threads are perfectly solid, but are all pierced longitudinally by a canal, which is often situated not quite in the centre; in some cases this is so large that the surrounding oxide of manganese becomes very thin, and a delicate tube is formed, while in many specimens the calibre is so small that the perforation can only be seen on close examination. The columns and threads are not all straight, but many are bent in various directions, and not unfrequently branched, the axial canals in all cases being preserved throughout the bifurcations.

These interesting structures in external appearance are rough and dull, but cross-sections exhibit a very distinct resinous lustre. The size of the columns is not great, their diameter never exceeding $\frac{1}{4}$ th of an inch, and their length being seldom much more than one inch; the tubular threads are sometimes four or five inches long, but their diameter is very much less than that of the columns, few of them having a section greater than $\frac{1}{16}$ inch across.

To account for the formation of these columns and threads appears, at first sight, a somewhat difficult matter, but after carefully taking into consideration the position of the mineral and the nature of its surroundings, an explanation is afforded which has been definitely proved to be correct by Mr. Dale, of Macclesfield.

The position which the greater part of the oxide of manganese occupies is about 14 feet from the surface, a depth to which the roots and rootlets of the surrounding wood are able to penetrate by means of the numerous cracks in the strata. Rootlets are to be seen in the fissures in many parts of the section, and in those which are lined with oxide of manganese they are especially abundant. They stretch across the cavities, and traverse the surface of the black mineral in all directions; and after closely searching for some time, it is possible to find specimens to illustrate all stages of the conversion of these organic bodies into columns and threads of oxide of manganese.

Many of the rootlets, probably in their first stages of decomposition, have assumed a reddish or unnatural brownish colour; others, in a later stage, exhibit minute patches of the black oxide studding their surface, appearing as if affected by a black mildew; others are almost entirely covered with the incrusting mineral; while, in the final stage, the whole of the organic matter has disappeared. In short, the rootlets are completely pseudomorphosed into hydrated dioxide of manganese by the action of the decomposing plant tissue upon a solution of some manganese salt.

These facts are interesting as showing that the deposition of oxide of manganese is still taking place, or, at least, did take place until the section was opened. There is now no perceptible percolating water, even in the most rainy weather, but the mineral is at all times moist.

With regard to these oxide of manganese pseudomorphs, it appears that very few cases of the alteration of organic matter into this mineral have been recorded. This oxide is not mentioned in Phillips's "Mineralogy,"* in the list of minerals said to occur as petrifications, but is referred to in the "Erster Nachtrag zu den Pseudomorphosen," by Blum. Wisner has described a fossil consisting of black oxide of manganese, which he stated, in 1842,† to be the first instance on record of this mineral occurring in a petrification; and again, in 1851,‡ he mentioned a fragment of an ammonite from Gonzen, near Sargans (Switzerland), which was fossilised in the same manner. Neither of these cases, however, can be regarded as quite similar to the pseudomorphism of the rootlets, since it was

not the truly organic matter that was mineralised, but the surrounding chiefly inorganic shell.

The mineral itself, as found in the bed of rock in the section at Ratcliffe Wood as already described, is of a bluish-black colour when freshly obtained, but assumes a browner tint on exposure: its hardness is less than 1. It is easily crushed into powder between the fingers, and has a characteristic crispness. When heated in a closed tube water is evolved, and under the blowpipe it is infusible. Its streak is of a dark yellowish-brown colour.

A quantitative analysis of the mineral gave the following as its percentage composition:—

MnO₂ = 33.634
Fe₂O₃ = 9.375
Al₂O₃ = 22.913
SiO₂ = 16.815
Water = 17.237

99.974

This analysis probably does not show the exact composition of the pure mineral, since it is almost impossible to obtain a sufficient quantity entirely free from the surrounding argillaceous matter.

IV. Distribution of MnO₂ in Ratcliffe Wood.

So far as I am yet aware, there is only one other spot in Ratcliffe Wood where oxide of manganese is to be seen occurring in the same form as the mineral in the section previously described. This is a few hundred yards to the east of the latter, and the deposit exhibits not only the same peculiarities but others which render it even more interesting. Here, as in the previously mentioned case, the mineral occurs both as an incrustation and pseudomorph after rootlets; but it is also in many parts covered with a thin layer of a white, translucent, crystalline mineral—a highly hydrated phosphate of alumina with a proportion of silicate—which, besides, mineralises rootlets in an analogous manner to the oxide of manganese.

In this same section, too, there is exposed a lenticular mass, 4 ft. 6 in. long and 3 in. in greatest thickness, which is black, earthy, and moist, and evolves chlorine on treatment with hydrochloric acid. It is situated in the midst of shales, and most of the small fissures for some distance beneath it are filled with black oxide of manganese.

The oxide of manganese occurs in many other fissures in and around Ratcliffe Wood, but nowhere so abundantly as in the sections referred to in this paper. The most widely spread form is a thin black film, not sufficiently thick to exhibit to the unassisted eye any pellet-like structure, as is the case with the mineral described above. Such a film is to be seen in some of the fissures in almost every section in the wood, and the fact that the oxide does not occur in larger quantities cannot be owing to the circumstance that there are no cracks exposed so large as those in which it is found in pellets, miniature columns, and threads, but in consequence of its scarcity in the stratum from whence it was derived; for in one quarry there are two faults which produce cavities and fissures of a much larger size, and yet these are well filled with brown iron ore with a comparatively small amount of MnO₂.

In the Triassic strata, on the E. side of the Red Rock Fault, this mineral occurs not only as an infiltration-product, but also as a part of the cementing material of certain thin beds of the sandstone.

V. References to Descriptions of Deposits of Hydrated MnO₂.

On referring to Bischoff's "Chemical Geology"* an enumeration of instances recorded before 1854 of the occurrence of deposits of hydrated oxide of manganese is to be found. Here no less than six cases are mentioned.

During the repair in 1840 † of a water channel hewn in

* Edit, Brodie & Miller, 1852.

† *Zeitschrift für Mineralogie*, &c.

‡ *Ibid.*

* Vol. i., pp. 160, 161, Edit. 1854.

† *Journal für prakt. Chem.*, vol. 21.

the rock in the neighbourhood of Nürnberg, an immense mass of hydrated oxide of manganese was discovered. A spring near the Cape of Good Hope, whose waters have a temperature of 170° F., is said to deposit in the discharge channel a very thick incrustation of the same mineral, extending to some distance from the spring.* A mineral spring at Carlsbad, depositing a mass resembling manganese, has been described by Kersten. Braconnet examined and described in 1821† a precipitate of oxide of manganese found in the outlets of the springs of Luxeuil. A deposit of the same mineral from the water in a mine at Freiberg has been analysed by Kersten and described in the "Archives für Mineralogie, &c." (vol. 16), and in this journal, also, Nögerrath has given an account of the nature and occurrence of the manganese ores in the Hundsrück, and in Soonwald, on the left bank of the Rhine.

VI. Associated Minerals.

The most important minerals associated with the oxide of manganese in the strata of Ratcliffe Wood, besides the phosphate of alumina already mentioned, are brown iron ore, calc spar, pearl spar, iron pyrites, and zinc blende. The brown iron ore occurs in thin incrustations, in fibrous stalactitic masses, and in hollow spheres which have, especially on the inner side, a very peculiar lustre. The calcite occurs in a crystalline state in small fissures in almost every section, and is found crystallised occasionally in the form $\frac{1}{2}$ R. and the combinations $\frac{1}{2}$ R. 16R. The pearl spar occurs in many fissures beautifully crystallised in the form $\frac{1}{2}$ R; it is tinged with oxide of iron, and the crystal faces are bent in the characteristic manner. Iron pyrites occurs abundantly, often perfectly crystallised; and zinc blende is found in small masses scattered among the crystals of calcite and pearl spar.

VII. Conclusion.

Oxide of manganese occurs in many places in the other Yoredale strata of the district, but nearly always in very small quantities. It also occurs widely spread throughout the overlying Millstone Grits; in these strata it forms dendritic markings radiating from the fissures in the rock, and constitutes a portion of the cementing material in many of the concretions.

In the sandstones of the coal measures, also, oxide of manganese forms part of the cementing material in many of the concretionary structures.

In fact, careful observations would probably show that oxide of manganese is quite as widely distributed as oxide of iron, the only difference being that the former mineral generally occurs in defined patches and in comparatively small quantities. The distributing causes seem to have acted as universally with the one mineral as with the other, but in the case of the manganese only small amounts were concerned, while in the case of the iron there was an almost unlimited supply.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 19, May 8, 1882.

Effects produced in a Vacuum by the Current of Gramme Machines.—MM. Jamin and G. Maneuvrier.—The effects are those of batteries with an intensification due to the enormous tension, and those of the coil with the intensification which results from a greater quan-

tity of electricity. When the vacuum reached about 12 m.m. the light began to spring out not in the form of a luminous arc confined between the points, but from all parts of the carbons with the ordinary aspect of the effluve in a Geissler's tube; each of them showed at once the appearances which characterise the two poles with the coil. The carbons are heated to whiteness in their entire length, and become volatilised. The receiver is filled with a blue gas, which gradually deepens almost to the colour of indigo. The vapours then condense on the sides of the receiver, rendering them opaque, and terminating the experiment. The deposit collected resembles very finely-divided carbon, and dissolves in nitric acid with effervescence and incandescence. The nature of this carbonaceous matter is under examination.

General Considerations on Apparatus for Preventing Conflagrations or Pyroscopes.—A. Ledieu.—The author, after criticising several devices, suggests the following: He interposes in a single circuit a cylinder of a material at once insulating and not brittle. This cylinder is filled with a liquid not easily liable to electro-lisation, and possessing a good conductive power which increases with the temperature. At each extremity of the cylinder there is a compact plug of tow, through which penetrates a platinum rheophore connected with one of the wires of the circuit. The author recommends alcohol for the liquid in question.

Report upon M. Béchamp's Memoir on the Albumenoids.—This report does not admit of abstraction.

Polarisation of Electrodes and the Conductivity of Liquids.—E. Bouty.—The conductivity of the liquid remains constant, in spite of the variety of electrolytic reactions of which the electrodes may become the seat. This conductivity is always greater than that possessed individually by the solution of any one of the elements of the mixture at the degree of dilution existing in the liquid. Consequently the molecules of each of the mixed salts take part in the transportation of the electricity, even when only one of the metals is deposited at the negative electrode. The polarisation of the positive electrode may generally be neglected. The polarisation of the negative electrode, very slight for currents of mean density, increases rapidly in either direction, and tends, for each mixture, to a fixed limit.

Magnetic Variations of Magnetised Rods during Storms.—G. de Lalagade.—Lightning, even at a distance, has a real action upon the magnetism of magnetic rods, though the influence under ordinary circumstances is neither strong nor rapid enough to be indicated by the needle of the compass.

The Composition and the Volume Equivalent of Pernitric Acid.—P. Hautefeuille and J. Chappuis.—The researches of the authors lead them to assign to this compound the formula $\text{NO}_5 = 4$ volumes.

Action of Potassa upon Lead Oxide.—A. Ditte.—Anhydrous lead oxide presents two distinct crystalline forms. In one it is of a rose-red, crystallising in cubes, or in solids derived from that form. In the other it appears in elongated rhomboidal laminæ or needles formed by the grouping of such laminæ. Its colour may be a greenish yellow bordering upon white, pure yellow, or greenish yellow of different shades, and deep green almost black. Its density varies from 9.1699 to 9.8835. At a slight rise of temperature all these crystals become red, whilst the red crystals require to be strongly heated before losing permanently their colour.

Chromium Phosphate and its Utilisation in Chemical Analysis and in Industry.—A. Carnot.—Chromium is always determined either as green oxide or as lead or barium chromate. It may also be exactly determined as phosphate, and this method is often convenient. On boiling a solution of a salt of chromium slightly acidified, to which has been added an alkaline phosphate and sodium acetate, the whole of the chromium is precipi-

* L'Institut, 1844.

† Ann. de Chim. et de Phys., 1821.

tated as phosphate. This method succeeds both with the green and the violet salts, chlorides and sulphates, and with the acetates, but not with the oxalates. It is also suitable for alkaline chromates, but in this case the action of the phosphoric acid must be combined with that of sodium thiosulphate (hyposulphite), which acts as a reducing agent. The solution of chromate, to which is added a sufficient quantity of phosphoric acid or of a phosphate, then of acetate, and lastly of hypophosphite, and which has been slightly acidified, is boiled for about an hour; it deposits all the chromium as phosphate, with a little sulphur derived from the hyposulphite. The phosphate precipitated is a green hydrate. It may be washed with boiling water, or, preferably, with hot solutions first of ammonium acetate followed by ammonium nitrate. On calcination it turns grey, and contains chromic oxide in the proportion of 51.86 per cent. In former researches on the determination of aluminium (*Comptes Rendus*, July 18, 1881), the author has shown that alumina can be exactly separated from chrome by converting the latter into an alkaline chromate, acidifying the solution slightly with acetic acid, and adding an excess of sodium phosphate. The mixture is boiled and filtered to separate the aluminium phosphate. When this is done, it is easy to determine the chromium by pouring into the liquid hyposulphite, and, if needful, a further quantity of alkaline phosphate, and boiling. The precipitate of chromium phosphate is then washed, ignited, and weighed. The same reaction is capable of industrial application. It yields an insoluble green colouring-matter, which retains, when dry, a very fine shade, and may be used in painting in place of the dangerous compounds of arsenic and copper. This colour, which is perfectly inoffensive, may also be used in dyeing, as the insoluble green phosphate may be produced in the fibre.

New Carbo-silicated Compounds.—A. Colson.—By heating to bright redness silicon along with lamp-black strongly compressed, the author has obtained compounds answering to the formulæ SiC_2 and SiC_3O_2 .

Homologous and Isomeric Rosanilines.—MM. Rosenstiehl and Gerber.—The authors consider that there exists a series of six rosanilines. The differences between any two consecutive terms of this series are slight. In a general manner, as the molecule becomes more complicated, the hydrochlorate becomes more soluble in water, crystallises less readily, and dyes wool a violet-red, which approaches more and more to a violet. The base becomes more soluble, the boiling-point of the carbon rises, and substitutions are effected less readily. The action of aniline, which in the first terms produces valuable blue colours, becomes less marked, the quantity of ammonia evolved decreases, and the colouring-matters obtained dye violet-blues.

Composition of Ash emitted by Vesuvius, Feb. 25, 1882.—L. Ricciardi.—The sample is black, rich in small crystals of leucite, and fragments of augite and magnetite. It is in great part magnetic, and when moistened reddens litmus.

Antiseptic Properties of Salicylic Acid.—E. Robinet and H. Pellet.—The authors pronounce salicylic acid a very efficacious antiseptic.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 1, May 6, 1882.

New Electric Lamp.—M. Solignac.—This paper cannot be intelligibly reproduced without the accompanying illustrations.

Relation between the Electromotive Force of the Battery and the Calories of Decomposition of Water.—Dr. D. Tommasi.—The author points out a remarkable difficulty. On the one hand, it is known that in order to decompose a molecule of water into its elements 69 calories are required, and that consequently any

action which does not liberate this quantity of heat is incapable of decomposing water. On the other hand, water may be decomposed by means of excessively feeble currents. Either, therefore, the thermic data are false, or the true cause of the polarisation of the electrodes is not yet known. The former supposition being inadmissible, there must be in the phenomena of polarisation something which has escaped observation. With a De la Rive condenser, a Daniell element incapable of decomposing water decomposes it so as to give off 18 to 20 c.c. of gas per minute. The condenser does not in any manner change the nature of the chemical reaction of the Daniell element, nor consequently its electromotive force. The supplementary calories are produced by the formation of zinc sulphate, which in case of the condenser is doubled.

Annales de la Société des Sciences Industrielles de Lyon.
No. 4, 1881.

Inconveniences arising from Certain Industrial Residues as regards Public Health.—M. Vanderpol.—The author points out the injurious action of sulphates, especially gypsum, in contact with organic matter and the carbonic acid of the atmosphere.

Moniteur Scientifique, Quenneville.
May, 1882.

Foreign Patents.—A list of chemical patents, chiefly German.

The Methods of Quinquaud for the Determination of Urea.—C. Arnold.—The result of the author's researches is that Quinquaud's method, as well as other processes for the determination of urea by means of sodium hypobromite, is entirely unfit for analyses requiring scientific exactness.

Metallurgy of Copper by the Moist Way.—Dr. Sterry Hunt.—From the *CHEMICAL NEWS*.

Determination of Small Quantities of Arsenic in Sulphur.—H. Schæppi.—Already noticed.

Carbonic Oxide: its Poisonous Action and its Presence in Houses.—M. Gruber.—The author considers that there is a grade of dilution below which this gas ceases to be dangerous. Foder's test—the reduction of palladium chloride—renders it possible to detect a proportion of carbonic oxide in the air four times smaller than what is sufficient to exert a poisonous action. M. Gruber has not succeeded in detecting this gas in the air of rooms heated with iron stoves.

Note on the Determination of Nitric and Nitrous Acids as Ammonia.—A. Guyard (Hugo Tamm).—Already inserted.

MEETINGS FOR THE WEEK.

- MONDAY, June 5th.—Society of Chemical Industry, 8 "On Turpentine—its Nature and Adulteration," by Professor Armstrong. "On Testing of Chimney Gases," by W. J. Lovett. "Estimation of HCl Free and Combined in Chimney Gases," by G. E. Davis.
- TUESDAY, 6th.—Royal Institution, 5. General Monthly Meeting. "Digestion," by Professor A. Gamgee.
- WEDNESDAY, 7th.—Geological, 8. Obstetrical, 8.
- THURSDAY, 8th.—Royal Institution, 3. "The Metals," by Professor Dewar.
- FRIDAY 9th.—Royal Institution, 8. "Excitability of Plants," by Prof. Burdon Sanderson, at 9. Quekett Microscopical Club, 8. Astronomical, 8.
- SATURDAY, 10th.—Royal Institution, 3. "Poetry and its Literary Forms," Professor D. Masson. Physical, 3. "Experiments on Vibration," D. F. Stanley. "On a Wind Integrator," by Walter Bailey.

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METHOD FOR ACCURATE AND RAPID
ANALYSES OF AIR.

By EDWARD W. MORLEY, M.D., Ph.D.,
Harburt Professor of Chemistry in Western Reserve College.

I HAVE made a series of daily analyses in duplicate of air collected at this place for six months beginning with January 1, 1880, and one for six months and twenty days, beginning October 1, 1880. The samples of air were collected in bottles with well-fitting glass stoppers. A few drops of solution of potassium hydrate being put into the bottle, this was set in the open air, and the air in the bottle displaced by sufficient aspiration, the observer keeping at a little distance to the leeward side. The stopper was then put in place and wet with the potassium hydrate by inverting the bottle and turning the stopper. Experiment showed that it was possible to keep samples for many days in this way with the certainty that they remained unchanged.

A mercury pump was used to withdraw the sample from the bottle. A rubber stopper was used to make the needed connection with the pump. Experiment showed that this rubber in contact with the alkaline solution does not absorb more than a hundredth per cent of oxygen from the air in the bottle in twenty times the period during which it was in contact with the air used in the analysis. The pump discharged the air into a jar standing over mercury in the laboratory trough of the apparatus for analysis.

This jar being lowered, together with the cistern, over the re-curved capillary end of the eudiometer tube, a certain quantity of air was taken into this tube. This quantity was measured approximately by using a journeyman pressure tube having a small bore. The quantity used was almost always the same, and occupied from 470 to 475 millimetres in length of the eudiometer tube, when the pressure on it was that of a column of mercury of this same length.

This quantity was then measured accurately with the standard pressure tube. This had a Jolly point in the vacuum at the level of the zero of the graduation on the eudiometer tube, which zero was at the top of the tube. The level of the mercury in the standard pressure tube being never permitted to vary more than a fraction of a millimetre, its vacuum was found to remain constant and unimpaired. When the mercury in it had been put in connection with the mercury in the eudiometer, and its upper level had been brought to the Jolly point by the use of a fine adjustment, the level of the mercury in the eudiometer was read with a microscope magnifying fifty diameters, and provided with an eye-piece micrometer. By this arrangement, when everything was prepared, it was possible to verify the contact at the Jolly point, to read the thermometer to the hundredth of a degree, and to read the level of the mercury in the eudiometer, in less than ten seconds. Uncertainty as to the actual temperature at the instant of final reading was in this way mostly avoided. This reading microscope is carried on a vertical cylinder which is solidly attached to the firm iron tripod which supports the whole apparatus. On this cylinder the mounting of the microscope can be clamped at the required height. The microscope is then made to give distinct vision of the graduation on the surface of the eudiometer. This graduation consists of lines not more

than the eight-thousandth of an inch wide, cut with a diamond. No errors exist amounting to the hundredth of a millimetre in the parts of the graduation which have been used in these analyses. When distinct vision is obtained of the graduation, a fine adjustment moves the microscope vertically till the terminal lines of the eye-piece micrometer coincide with two lines of the graduation on the eudiometer. If now the horizontal focussing movement carries the microscope forward about half an inch towards the eudiometer, the microscope will give distinct vision of the meniscus in the tube, and its level can be read by the divisions of the eye-piece micrometer, which represent the divisions on the surface of the tube carried forward optically into its interior. It would be easy to show how far the use of such an arrangement is superior to that of a cathetometer for the purpose in hand, in accuracy, in rapidity, and in simplicity of reduction for expansion of the scale.

The measured quantity of air was next transferred to a jar standing over mercury in the laboratory trough.

A quantity of hydrogen amounting to about 63 per cent of the air taken was next measured approximately, and added to the air in the jar. This amount was always the same, so that any errors which were a function of the quantity of hydrogen should be constant in amount, and should not therefore affect the differences of the analyses. 63 per cent was used in order that the last and first readings of volume might be made with the same position of the reading microscope.

After the air and hydrogen had had time thoroughly to mix they were transferred back to the eudiometer, measured, expanded, exploded, and again measured. The expansion was always the same. In the transfers mentioned there is absolutely no possibility of loss or of admixture by leakage except by gross carelessness. The only place where leakage could take place is the stop-cock at the top of the eudiometer. This stop-cock was specially made for this place, and has not yet been found to leak, though it has been tested for ten minutes against an internal vacuum before or after each analysis.

Two coincident readings were obtained for each measurement, though the result was always calculated from the last reading. To secure accurate determinations of temperature, the eudiometer and pressure tubes are enclosed in a box with plate-glass front and back, containing about 10 litres of distilled water. This is vigorously stirred, except at the instant of reading the microscope, by means of a current of air from a condensing pump driven by power. I have had no difficulty in getting the required two coincident readings in half a minute when the thermometer was rising; but when the thermometer is falling, the difficulty in getting a reading of the thermometer which shall really represent the temperature is enough to make work very vexatious, for an error of a hundredth of a degree in the difference of temperature at two measurements in the same analysis is close upon the limit of allowance.

Great care has been taken to obtain hydrogen of sufficient purity. In the earlier analyses a Bunsen's decomposing cell of the common form was used. It then often happened that the analysis made with the first hydrogen obtained after an interval of rest would give results showing a deficiency of oxygen of about a hundredth of one per cent. Often analyses had to be rejected until the cell was freed from compounds of hydrogen with zinc or carbon, which had been produced by local action at the surface of the zinc. Finally, a cell was constructed which could be every morning connected with the air-pump and exhausted of hydrogen, so as to remove these compounds of hydrogen with zinc or carbon, whether they had risen through the liquid or were still adherent to the zinc plate or dissolved in the dilute acid. The cell had a mercury stop-cock which interposed a barometric column against the leakage of air into the cell; but for additional security, the hydrogen coming from it passed through several inches of active platinum-black. In this way I have now

secured a supply of hydrogen which probably never occasions a difference of a five-hundredth of one per cent in two analyses of the same sample. Experiment shows that hydrogen may safely be left standing over mercury in a clean bell-glass for a long time. I have left two samples for eleven weeks, which samples then were used in a duplicate analysis of a sample of air against a duplicate analysis of the same sample made with two samples of hydrogen just from the decomposing cell. Hydrogen was therefore sometimes used which had stood for a few days. Duplicate analyses were always made with different samples of hydrogen.

It may be observed that the corresponding measurements of different analyses were made under identical conditions. The calibration error, and the error caused by the imperfect parallelism of the reading microscope in its different positions, therefore, disappear from the *differences* of the analyses of different samples. The same is true of the error caused by the production of water in the eudiometer between the second and third measurements in each analysis. No correction has been applied for this error, because the distribution of the water above and below the meniscus cannot be easily determined. The amount of water adhering to the interior of the eudiometer before the commencement of an analysis has also been made always approximately the same. This has been accomplished by producing a vacuum in the eudiometer after the analysis, and the letting the mercury rise in it with a determinate velocity: when the eudiometer is clean considerable uniformity is thus obtained.

In making observation as accurate as is required for my purpose, it is very important to keep the interior of the eudiometer very clean. A little irregularity in the film of water through which the meniscus is seen will spoil the reading. My eudiometer tube is cemented into a brass fitting which rests in a seat ground for it in the bottom of the enveloping box mentioned above. The eudiometer can be disconnected, removed, washed with caustic potash and shot, rinsed out with dust-free distilled water, and replaced ready for analysis, in an hour. The accurate fitting of the ground seat makes it possible to restore the zero of the graduation on the tube to the same level within the two-hundredth of a millimetre, without even the bestowal of any thought on the matter. With this facility the eudiometer has been kept sufficiently clean for accurate reading.

It is of course possible that the mean of all my analyses with the new apparatus is affected with a measurable constant error, though no measurable error has yet been traced to any assignable source. But it is certain that the differences in the means for different periods are affected with but very small errors. During the most favourable conditions under which I have used the apparatus, taking seventy minutes for each pair of analyses of the same sample, the mean error of a single analysis was, for half a month, less than the thousandth part of 1 per cent. Having commonly to work at odd times, and more rapidly than this, the accuracy attained has been less; but, for the whole seven hundred and eighty-eight analyses made with it, the mean error of a single analysis has been less than the two hundred and eightieth of one per cent. If, then, two samples of air differ by one-fiftieth of one per cent in their contents of oxygen, the fact of a difference can be detected with a degree of probability nearly approaching certainty, at an expenditure of time not exceeding one hour for each sample.

Length of the Sparks from the Discharge of an Electric Condenser.—E. Villari.—On discharging a condenser and causing it to produce a spark or two, the length of the former is not equal to the sum of the lengths of the latter, and the sum of the lengths of the sparks is not always constant.—*Comptes Rendus*.

REMARKS ON TABLES FOR THE REDUCTION TO ZERO OF THE MEASURED VOLUMES OF GASES.*

(ABSTRACT.)

By EDWARD W. MORLEY, of Hudson, Ohio.

THE tables of Bunsen, Sutton, and others, are too bulky, from not adopting the form in which all logarithmic tables are now printed.

Many are also clumsy, giving seven decimal places of the logarithm. Four places give as much accuracy as the manipulation requires in any but the most refined work: five places more than equal the accuracy of the best work in gas analysis.

All tables for the purpose give a logarithm to be subtracted from the sum of the logarithms of the volume and tension observed. The computer, therefore, has mentally to take the arithmetical complement of the tabular number, in order then to add the three logarithms in one operation. But such tables, being intended for this one purpose only, ought to give this complement by inspection.

All tables at present published use the coefficient of the absolute expansion of air. For refined work, a second and even a third correction is then necessary, with a second and third tabular number. But by using the coefficient of the apparent expansion of air, under the conditions of measurement in analysis, the whole correction can be computed in a single operation, and with but a single tabular number. The same table may be used for ordinary work, for its use involves no more labour than that of any other table.

For the most refined work, there have to be taken into account the cubical expansion of the eudiometer, the linear expansion of the scale on which pressure is measured, and the inequality of the degrees of the mercury-in-glass thermometer. We should therefore use, for the computation of tables for the purpose mentioned, the coefficient of expansion of air added to that of mercury and diminished by the sum of the cubical expansion of the eudiometer and of the linear expansion of the scale. This gives the coefficient for a degree of the ideal air thermometer, and must now be multiplied by the factor which will reduce the degrees of the air thermometer to those of the mercury thermometer.

Since the nature of the glass of which a given mercury thermometer is made affects this factor, it is best to determine the joint effect of this factor and of the correction for errors in calibration of the given thermometer by a simple process which gives very satisfactory results. A convenient volume of air is measured at a temperature near freezing-point. The same volume is also measured at about 10°, 20°, and 30°. The corresponding temperatures are carefully observed, but the apparent volumes are computed without reduction to zero. The table for temperature corrections is now computed with that coefficient which will reduce the apparent volumes at the three higher temperatures to the volume at the lower temperature. This coefficient will be different in the different intervals, partly owing to errors of calibration, and partly to the inequalities of a perfect mercurial thermometer. With such a table computed for a given thermometer, reductions may be made, even when another thermometer is used, with more accuracy than when the reductions are made from a table which does not regard the difference between the degrees of the mercury and of the air thermometer, and with far more accuracy than when the reductions are made from a table which regards only the absolute expansion of air.

* *Proceedings of the American Association for the Advancement of Science*, vol. xxix., Boston Meeting.

THE COST OF ELECTRIC LIGHTING BY
INCANDESCENCE.

By WILLIAM CROOKES, F.R.S., &c.

THE following letter appeared in the *Times* of June 5th, 1882:—

Sir,—For more than six months I have had the principal reception rooms in this house almost exclusively lighted by incandescent electric lamps, the electricity being generated on the premises; and as so many different opinions have been given as to the expense of lighting by incandescent lamps, some saying that electricity is many times more expensive than gas, while others maintain that it is cheaper than gas, the results of my own private experience in electric lighting may not be without interest.

The dynamo machine—a small Bürgen—is driven by a 3½-horse power Otto gas engine, which under favourable circumstances will develop 5-horse power. Owing to the absolute necessity which exists in a private house in this neighbourhood that there should be no smell of unconsumed gases and no noise of machinery either in the house or out in the street to annoy my neighbours, it became necessary to add silencing chambers to the air inlet and the exhaust pipe, and to carry the products of combustion high up on to the roof. The obstructions thus put in the way of the free working of the engine necessarily affect the horse-power, so that when a further deduction is made for the power absorbed in running the machinery when no electricity is being generated, I find I have not more than two horse-power available for the production of electricity. This is far from sufficient to drive the dynamo machine to its full power, therefore I lose greatly in efficiency both in the engine and the dynamo machine. However, I have only to deal with the facts as they show themselves in my experience. The total necessary expense of the installation has not exceeded £300, including wiring the house and making the lamps, although the actual expense to me has been much more, as I had to excavate and build underground rooms for the machinery. Where stables or outbuildings are available, or if a little noise is not prohibited, a less expense will give more available electricity, and where steam power can be used the cost will be diminished fourfold. The gas engine requires five minutes' attention every day to fill the oil cups and start it. Once started, it will go on without attention for six or eight hours. It is overhauled and cleaned once a week; an engineer does this on a Saturday afternoon, at a cost of 2s. 6d.

The maximum electric current which I can get is 11½ amperes through an external resistance of 12 ohms. The lamps fed by the current are distributed as follows:—

In the library I have ten 20-candle lamps; in the dining room I have ten 20-candle lamps; in the drawing room I have a cluster of twenty-one 4-candle lamps in an electrolier in the centre of the room, and six 20-candle lamps. One or two lamps are in other parts of the house; the total number of lamps about the house being about 50. I cannot, however, have this number alight at once, as the machine as at present driven will not feed so many. It is, however, sufficient to light any two rooms perfectly, and the third partially.

Switches are placed in cupboards in each room, so as to turn any desired combination of lamps off and on. Main keys, cutting off the whole of the current at once, are placed in the engine room, and also in my laboratory at the place whence the main wires diverge to the different rooms.

Owing to inexperience in adjusting the strength of the current to the kind of lamp used, and to the variety of systems, &c., I was then testing, the breakages during the first three months were somewhat numerous. For the last three months, however, since passing the experimental stage and settling down to a definite system, I have

used lamps made by myself, and during this time only one lamp has gone.

The gas burnt in the engine when the machine is feeding its maximum number of lamps (twenty-two 20 candle lamps) is about 550 cubic feet in five hours, costing, at 3s. 2d. per thousand, 1s. 9d. Assuming that the light is required on an average five hours a night all the year round, this would come to £2 9s. a month, or £31 17s. per annum.

To obtain, not an equal amount of light, but a fairly good light from gas, to replace this amount of electric light, would take 30 gas-burners, each burning 5 feet per hour, or 750 cubic feet in five hours, costing 2s. 4½d., or £3 6s. 6d. per month, or £43 4s. 6d. per annum.

The expenses, therefore, per month stand as follows:—

Electricity—

Gas consumed in engine	£2 9 0
Engineer once a week to clean and oil machinery	0 10 0
	2 19 0

Lighting by gas alone	3 6 6
Balance in favour of electricity per month	0 7 6
Or per annum	£4 17 6

I have here charged only the current expenses. Strictly speaking, I ought to charge interest and wear and tear, but these are more than counter-balanced by the incidental advantages of electric lighting. With it the ceilings do not get blackened, the curtains are not soiled with soot and smoke, the decorative paint work is not destroyed or the gilding tarnished, the bindings of books are not rotted, the air of the room remains cool and fresh and is not vitiated by the hot fumes from burnt or semi-burnt gas, while fire-risk is almost annihilated, as no lucifers are used, and the lamps are high up out of reach.

In the above statement I have compared electricity with gas as an illuminating agent. This is giving gas an unfair advantage. The twenty-one electric lamps in my drawing-room do not replace gas jets, but wax candles, whilst the incandescent lamps in the dining-room replace candles and oil lamps. The actual expense of these per night comes to three or four times the cost of electric illumination.

Moreover, I am producing my electricity at an extravagantly dear rate. The dynamo machine works only about half power, and this greatly reduces its efficiency; while Messrs. Crossley tell me that a consumption of over 100 feet of gas per hour ought to give me double the power I get out of the engine; and doubtless it would do so were it not for the back pressure produced by the silencing boxes.

When electricity is laid on to our houses as gas is, all these extra expenses and difficulties will disappear; and if, as I hope I have shown, electricity, heavily handicapped as it is in a private house, compares favourably with gas even in the matter of cost, it will necessarily be far cheaper than gas when it is supplied wholesale from a central station.—I am, &c.,

WILLIAM CROOKES.

7, Kensington Park Gardens,
London, W., June 1st, 1882.

Existence of Lithia and Boric Acid in Notable Proportions in the Water of the Dead Sea.—M. Dieulefait.—In 1 c.c. of Dead Sea water there is a quantity of lithia sufficient to show the spectrum of this substance at least a thousand times. The same water contains also so much boracic acid that it can be practically recognised in the product of a single c.c. of this water. Hence the author infers that the present waters of the Dead Sea are the residues of an inland sea analogous to the Caspian or the Karabogahz.—*Comptes Rendus*.

NOTES ON THE DETERMINATION OF
PHOSPHORIC ACID.

By CARL MOHR.

JOULIE's method for determining the compounds of phosphoric acid soluble in ammonium citrate prescribes the volumetric estimation of the ammonium-magnesium phosphate with a solution of uranium. The precipitate is to be dissolved in dilute nitric acid, the solution slightly supersaturated with ammonia, and the precipitate redissolved in dilute acetic acid. This method of treatment introduces into the solution too large a quantity of neutral ammoniacal salts, which are known to have a retarding effect on the appearance of the final reaction with potassium ferrocyanide. It is also known that large quantities of neutral calcium and alkaline salts have the same disturbing influence, rendering the results always too high. It is hence of great importance, in determinations with uranium, to keep within the boundaries which were observed in standardising the solution. This state of affairs has led the author to obtain a double standard for his uranium solution; the one for solutions poor in lime, such as superphosphates, Mejillone's guano, &c.; and the other for solutions rich in lime, like the marl phosphates. The differences are not very considerable, but still enough to have a noticeable effect in the result. Thus for superphosphates 1 c.c. of the uranium solution represented 0.0041 phosphoric acid, but for marl phosphates only 0.0039 grm.

The author has undertaken to determine, by a series of comparative experiments, the influence of combined ammonia in titrating ammonia-magnesium phosphate with uranium, and also to decide in how far this ammonium compound has a retarding action upon the appearance of the final reaction. For this purpose he prepared a solution of pure calcium phosphate in dilute nitric acid. In one series of experiments portions of 10 c.c. of this solution were mixed with sodium acetate and titrated with uranium. In the second series the lime was thrown down with ammonium oxalate, and the phosphoric acid with magnesia. In both series equal quantities of uranium solution would be consumed if the ammonium compound had no disturbing influence.

In direct titration the average quantity of uranium solution consumed was 9.46 c.c. If the phosphoric acid was precipitated as ammonio-magnesium phosphate, dissolved and titrated, the average was 9.37.

These experiments prove that there is a sufficient agreement between the two processes if in using the second or indirect method the precaution is adopted of allowing the precipitate and filter to stand for some time in a warm place, so that the free ammonia of the washing water may evaporate.

In vol. xix., p. 150, of the *Zeitschrift*, the author has communicated a process for determining phosphoric acid with uranium in presence of iron. This process he has since then frequently proved, and can recommend it to technical analysts as accurate. The procedure suggested is found tedious and disadvantageous, so that he has felt induced to adopt a modification. In his original memoir he proposed to throw down the ferruginous solution of phosphate partially with uranium, and then to add so much potassium ferrocyanide as suffices for transforming the ferric phosphate. This transformation is often incomplete if but little iron oxide is present, as in animal charcoal and guano. It is hence every way better to throw down the iron with potassium ferrocyanide before precipitating the phosphoric acid. Filtration is in either case unnecessary. Instead of precipitating the iron with pulverised potassium ferrocyanide, as directed in the author's first memoir, he prefers a 5 per cent solution, which is introduced into a small bulb-pipette drawn out below to a fine orifice. To regulate the outflow of the liquid a glass tap is adapted below the bulb.

When precipitating a ferruginous phosphatic solution it

is needful to ascertain previously how many drops of the ferrocyanide solution are necessary. The solution is dropped in till a drop of the liquid gives a faint reddish or brown colouration. To a second portion there are added one or two drops fewer, and it is ascertained by a second test with uranium solution if the precipitation-point has been reached. It is necessary to count the drops exactly. In metallurgical or mining establishments where ores of the same class are always examined, a single determination of the number of drops is sufficient to show how much ferrocyanide solution is always to be used for the precipitation of the iron.—*Zeitschrift für Analyt. Chemie.*

ON THE
ALKALINITY OF POTASSIUM MONOCHROMATE
AND ON THE
TRUE COLOURING-MATTER OF LITMUS.

By M. RICHTER.

POTASSIUM monochromate in solution reacts upon turmeric and litmus like an alkali. This fact is the more remarkable as it is a neutral, well-crystallised salt, and its behaviour in other respects cannot be harmonised with alkalinity. This alkalinity may be explained either as due to a mechanical admixture, derived from the preparation of the salt, or to a peculiarity of a chemical nature and essential to the existence of the compound, or to the oxidising action of chromic acid.

Of these three views the third has been proved by the author, by means of very simple experiments. The first has been refuted by the following experiment:—Pure potassium monochromate was dissolved in water and precipitated with alcohol six times in succession, by which process any caustic alkali would be removed, since potassium hydroxide is soluble in alcohol. The salt, after being thus purified, reacted as before strongly alkaline. The alkalinity is therefore due only to the behaviour of the chromic acid as an oxidising agent. To determine this point litmus, turmeric, and phenol-phthaleine were applied comparatively. The solution of the salt gave, with the red colour of the litmus, a green mixed colour, and with red litmus paper a blue-green. Turmeric tincture and paper were turned to a permanent dark red-brown. Solution of phenol-phthaleine and paper saturated therewith remained unaffected. But if a trace of alkali was added to the monochromate the well-known intense red colouration of phenol-phthaleine was at once apparent. This indicator is decidedly preferable to the others.

Herewith a proof is furnished that potassium monochromate does not exert an alkaline reaction in the first moment, as in this case the reaction of phenol-phthaleine would appear, but the alkalinity is first produced by the influence of the chromic acid upon the colouring-matter. The author advances here two suggestions which both seem very hazardous, as further research is needed to give a positive result.

1. The chromic acid oxidises the colouring-matter so as to produce coloured compounds.
2. In the oxidation of the colouring-matter the chromate is decomposed, and caustic alkali is liberated, which acts upon the colours.

The former hypothesis is preferable if the action of the chromate is kept in view. If red litmus paper is spotted with a solution of the chromate it turns green at the edges. In other words, the chromic acid oxidises the red colour to a blue compound, which forms a green with the yellow colour of the excess of the salt. The blue litmus is therefore a product of the oxidation of the red, which must be regarded as the original colouring-matter.

Another proof that the blue is a compound derived from the red is already known. If blue litmus solution is pre-

served in a closed bottle the liquid loses its blue colour and acquires a reddish tint. If poured upon a plate, so that the air has everywhere access, the blue colour is soon restored. The air exerts here, without doubt, an oxidising action, though less rapid and energetic than that of chromic acid.—*Zeitschrift für Analyt. Chemie.*

ON THE
HYDROSULPHATE OF NICKEL SULPHIDE.

By M. H. BAUBIGNY.

In the action of sulphuretted hydrogen upon a solution of nickel sulphate the author describes the progressive formation of the metallic sulphide to the existence of a nickel sulphide hydrosulphate, a compound which in consequence of its stability being variable with the temperature and the conditions of the medium would act by its successive decompositions and reformations, and determine thus reactions which sulphuretted hydrogen alone cannot produce under the same circumstances.

It is found on filtering a liquid in which nickel sulphide has been thrown down by the action of sulphuretted hydrogen that, if this filtration is not effected until the sulphide has been deposited, the odour of the sulphuretted hydrogen becomes more penetrating on pouring upon the filter the portion of the liquid charged with suspended sulphide. It is therefore not surprising that the analysis of this precipitate, washed and dried, all causes of apparent alteration being excluded, has never yielded results differing from the exact composition of nickel sulphide, NiS. As the hydrosulphate cannot be isolated, the author proves its existence indirectly.

In one of his experiments the excess of sulphur over and above the weight answering to the composition of nickel sulphide has been as much as 14 per cent. This excess of sulphuretted hydrogen can only exist in the presence of the nickel sulphide, and it is by no means due to a simple physical condensation by the sulphide. If the same experiment is repeated with zinc the same excess of sulphur is found. The author has shown that nickel sulphide acts chemically upon the solution of acid nickel sulphate in presence of sulphuretted hydrogen, whilst zinc sulphide does not act in the same conditions as nickel sulphate, as inversely the author shows that zinc is not precipitated from a solution of acid sulphate in the presence of sulphuretted hydrogen by the metallic sulphides which throw down nickel under the same circumstances. If nickel sulphide and zinc sulphide retain sulphuretted hydrogen in consequence of simple condensation, that is to say, in the same physical state, both ought to act chemically in the same manner. If they act differently it is because there is more than a difference of physical state. Sulphuretted hydrogen forms with zinc sulphide and nickel sulphide true combinations, i.e., hydrosulphates of sulphide. Experiment confirms thus the theoretic prevision announced by M. Berthelot relative to the existence of the hydrosulphates of sulphides.

The causes which govern these differences of action of various metallic sulphides upon the solutions of the acid salts of other metals in presence of sulphuretted hydrogen will be the subject of a special memoir.—*Comptes Rendus.*

Laws of the Solubility of Carbonic Acid in Water under High Pressures.—S. Wroblewski.—The temperature remaining constant, the coefficient of saturation (i.e., the quantity of gas measured in c.c. at zero and under the pressure of one atmosphere), dissolved in 1 c.c. of water, increases much less rapidly than the pressure, and tends towards a certain limit. If the pressure remains constant, this coefficient augments as the temperature diminishes.—*Comptes Rendus.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 1, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—T. Hughes, H. Jordan, L. Reed, E. S. Spalding, P. G. Sanford, J. E. Stead, C. J. Waterfall.

The PRESIDENT then called on Mr. WARINGTON to read a paper "*On the Determination of Nitric Acid in Soils.*" As to the taking a sample of the soil, a detailed description of which the author promises to give on a future occasion, it is important to sample the sub-soil as well as the surface, and to take the samples after dry weather. Thus Boussingault, August 9, 1856, found that after dry weather the surface soil of a kitchen garden contained nitrogen as nitrates = 29.2 per million; a few weeks after, August 29, rain having fallen, the nitrogen = 1.2 per million; October 10, after dry weather, the nitrogen was 41.3 per million. It is necessary to dry the sample speedily, else nitrification proceeds. Drying at 100° may occasion a loss of nitrates in proportion to the wetness and mass of the soil and its richness in organic matter. Drying at a high temperature also greatly increases the soluble organic matter in a soil. The plan adopted by the author is to break up the soil to small pieces, place these in paper trays, and dry in a stove at 55° (the temperature at which Schloesing and Müntz state that nitrification ceases). Soils thoroughly dried in dry air seem to undergo very little change by keeping. The method commonly used to prepare an extract of the soil is to shake 500 or 1000 grms. of soil with its own or twice its own weight of water, and take a known portion of the solution for analysis. This method is tedious and yields a very dilute and turbid extract. The author extracts 200 to 500 grms. of dry powdered soil with cold water, on a vacuum filter, until 100 c.c. have passed through. This extraction takes from ten to forty-five minutes, and all the soluble salts can be extracted with the utmost ease. Thus 7 lbs. of dry powdered soil, in a column 8 inches deep, were extracted with cold water. All the chlorides and 99 per cent of the nitrates present appeared in the first 150 c.c. of extract. In dry soil, if free from fissures, a descending column of water dissolves all soluble salts at its lower edge, and pushes the solution before it until an area of discharge is reached: thus the salts are obtained in the form of a concentrated solution. If, on the other hand, wet soil is employed, the whole of the water must be expelled to obtain all the soluble salts present, and a large and dilute extract is therefore obtained. For the analysis of the extract, the Crum-Frankland process was at first employed; the greater part of the organic matter has to be removed by treating the highly concentrated extract from the soil with strong alcohol, the filtrate being evaporated to dryness and dissolved in a small quantity of water. If a drop of dilute hydrochloric acid be introduced with the purified soil extract into the shaking tube, to make the action on the mercury more energetic, very fair results, if the amount of nitric acid be not too small, may be obtained. The determination of the nitric acid is now made by a modification of Schloesing's method, the nitric oxide being measured. When this method is used no purification of the soil extract is required, and much larger quantities of nitrate may be operated on. The results obtained by this method are rather higher than those yielded by the Crum-Frankland process.

The PRESIDENT said that the determination of the nitrogen in a soil was of the utmost importance, but until the method of collecting a true sample of the soil was introduced, it was difficult to know what the results ob-

tained really represented. When at Rothamsted a balance of the nitrogen given to the land as manure and the quantity present in the crops was first struck; it was found that only one-third of it could be accounted for in the crops. It was suggested that the excess accumulated in the soil, but it has been proved that this accumulation varied not with the quantity of manure applied, but with the growth on the soil; with a bad growth no accumulation took place. This question as to the ultimate fate of the nitrogen lost was one of the greatest importance in agricultural chemistry.

Dr. RUSSELL then read a paper "*On a Spectroscopic Study of Chlorophyll*," by Dr. RUSSELL and Mr. LAPRAIK. The authors have endeavoured to throw some light on the properties and nature of this body by following out its spectroscopic changes. The colouring-matter was usually extracted by a mixture of alcohol and ether. By chlorophyll the authors mean the body or bodies giving a particular absorption-spectrum, and they have assumed that a particular absorption-spectrum is a complete identification of a particular substance. In all leaves investigated by the authors, chlorophyll exists, and is extracted by alcohol and ether, the solution giving the well known absorption spectrum of four well-marked bands. This substance is exceedingly sensitive to the action of acids, a mere trace of hydrochloric acid altering the absorption-spectrum, causing one band to disappear; the addition of a further quantity of acid gives another well-marked absorption-spectrum. The action of hydrochloric acid takes place in two stages, both characterised by absorption-spectra. The first is called by the authors the "half-acid" spectrum; the second the "acid" spectrum. This action is not peculiar to hydrochloric acid, but is also brought about by sulphuric and nitric acids. If tartaric, citric, or oxalic acid be used the action ceases at the half-acid stage. The same half-acid spectrum can be obtained by evaporating to dryness a solution of chlorophyll at 80°, or above: the residue on re-solution gives the half-acid spectrum. If a chlorophyll solution be precipitated by alum, it is converted into the half-acid substance, but basic lead acetate precipitates the chlorophyll unchanged. The leaves of some plants, as the vine, &c., yield such an acid extract that the chlorophyll is converted into the half-acid modification; by adding calcium carbonate during the extraction, a solution of normal chlorophyll is obtained. Alkalies produce a characteristic change in the absorption-spectrum of chlorophyll; all the bands disappear except the well-marked band in the red, which spreads to the blue. By the further action of caustic potash or soda this broad band splits into two. The half-acid modification gives with alkalies a spectrum distinct from that just described. The one-banded spectrum produced by the action of alkalies can also be obtained by precipitating chlorophyll with copper sulphate, washing the precipitate till free from copper, drying, and dissolving in alcohol and ether. This one-banded modification seems to be most stable; it can be dissolved in strong sulphuric acid and re-precipitated unaltered by dilution with water. The authors have also made some experiments as to the action of light on these substances. In conclusion the authors referred to the various tints of green in young and old leaves, and suggest that the light tint might be due to dilution of the chlorophyll.

Some photographs, by Capt. ABNEY, of the various absorption-spectra were exhibited.

After a short discussion, in which Dr. Schunck, Prof. Lankester, and Messrs. Smee and Cross took part, the Society adjourned to June 15, when a ballot for the election of Fellows will be held, and the following papers read:—"Note on the Preparation of Amido- β -naphthol and β -naphtha-quinone," by C. E. Groves; "On Hæmatein and Brazilien," by J. J. Hummell and A. G. Perkin; "On the Determination of Nitric Acid as Nitric Oxide by means of its Reaction with Ferrous Salts," Part II., by R. Warington.

NOTICES OF BOOKS.

Spon's Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products. (Division V.) Edited by C. G. WARMFORD LOCK, F.L.S. London and New York: E. and F. N. Spon.

WE have here the concluding part of Messrs. Spon's great undertaking. In the preface attention is justly called to the prominence which has been given to raw commercial products. These are here dealt with on a more comprehensive scale than in any similar publication in the language, and the information thus given cannot fail to be valuable to, and valued by, a large part of the community. The oils and fats, gums, resins, starches, tanning, and dye-wares have been described with remarkable care and fulness, and even the less known—and for the present less important—articles are not overlooked. The complaint is made, not without a show of reason, that the average British manufacturer is ignorant of the needs of every industry but his own. Hence he is apt to overlook serviceable raw materials, and to be ignorant of possible modes of utilising his refuse or waste. The profitable application of waste is, indeed, a subject which has been in view through the entire work, and not a few suggestions have been thrown out in this direction. We have, however, sometimes doubts whether the public is not too sanguine in its expectations of the benefits to be derived from the utilisation of waste. Reference is often made in speeches and in the press to the benefit which the alkali manufacturers have derived from having been compelled to condense their hydrochloric acid instead of turning it out into the air; but, in consequence, the supply of hydrochloric acid has become so abundant that it is scarcely marketable. It has been used in the manufacture of chloride of lime to such an extent that the demand for that article is nearly outstripped by the supply. Some one is therefore wanted who can point out a use for this acid on the spot where it is produced. Before the by-products and refuse of our chemical works can be profitably dealt with inland, transport must be much cheaper than it is. But as Mr. Peter Spence, of the Manchester Alum Works, has most ably shown, exorbitant and arbitrary rates are charged by the railway companies, who have been foolishly permitted to get many of the canals into their hands, and thus do away with all chance of competition.

Turning to the various substances dealt with in this volume we notice a rather brief section on pigments. White-lead is dispatched in five lines, only one of the various processes for its manufacture being described, and that, too, in the briefest manner. Brown pigments, such as the umbers, are omitted entirely. Under yellows we miss cadmium-yellow, so valuable for its permanence, and the lemon and orange varieties of chromate of lead have also been overlooked. The machinery for grinding paint is figured and described at considerable length.

Pottery in its various branches is discussed in an extensive article, which is abundantly illustrated.

The section on "resinous and gummy substances" is one of the longest in the entire work, extending to upwards of 70 pages. We should think that these two great groups of vegetable products had better have been treated separately. The distinctions between gums and resins are indeed pointed out in the beginning of the article, but as they are afterwards described together alphabetically it is possible that the reader will sometimes feel at a loss. The tabular scheme for the detection of true resins, gum-resins, and balsams, taken from Hirschmann, will be of great utility in the analysis of medicines, varnishes, and other mixtures of organic matter.

Common salt is very ably treated from a chemical and geological as well as from an industrial point of view. We find mention of the curious fact, that if the whole of the known deposits of rock-salt in the world were to be added to the waters of the ocean they would but raise its

standard of saltiness to an insignificant extent. The bulk of rock-salt which the evaporation of the entire ocean would yield is estimated at 4,419,360 cubic miles.

On the eastern coast of the Caspian a very curious phenomenon is in progress. The Kara Boghaz is an estuary nearly separated from the main body of the sea by a bank through which there is an inlet. The evaporation from this gulf is so great that a current continually sets in from the main body of the Caspian; and as there is no return current, the water of the gulf becomes more and more saliferous, and a deposit of salt is in course of formation. In process of time this gulf will be cut off from the Caspian, and will then be dried up and become an extensive deposit of salt. What renders this supposition the more probable is that there are along the shores of the Caspian, but now detached from it, several salt lakes in various stages of desiccation. These phenomena may be commended to the notice of all who are anxious to form an internal sea in the Sahara.

In the section on silk there is a careful account of the product of the common or domesticated silkworm, and of the so-called wild silks which have been of late so carefully examined as to their industrial capabilities by Mr. T. Wardle, M. A. Wailly, Major Coussmaker, and others.

Under the head "Skins" we find mention of the curious fact that salmon-skins make leather as tough as wash-leather and about the thickness of dog-skin. The importation of goat-skins from British South Africa amounts in a single year to upwards of 900,000. That so many goats exist there fully explains the treeless and arid state of most of that region.

The soap manufacture is ably and fully described. We find mention of the adulterations of soap, but it is brought under the notice of the reader that a soap free from any impurities may do mischief if it has not been skilfully and carefully prepared. Unsaponified fats and free alkali are often the cause of much trouble to woollen manufacturers, dyers, &c. An instructive case is given where a good soap had produced unsatisfactory results because the consumer's workmen had not taken the trouble to dissolve it, but had applied to cloth—probably in fulling—a solution containing undissolved pieces. This instance shows how much chemical manufacturers are at the mercy of careless, or probably malicious, workmen, and may explain, if it does not justify, the questionable means sometimes used to secure the good will of the latter.

The chapters on starches and on the astringent or tanniferous drugs are of a satisfactory character. The determinations of tannin in the various wares are accurate as averages, and agree with the comparative efficiency of the various drugs in practice. Till recently the published analyses of such products were wild in the extreme.

The work is provided with a most elaborate index. In surveying this encyclopædia as a whole we can have no doubt whatever as to its great value. The various articles in the work are of course not equal in thoroughness and accuracy. Some of them may perhaps be considered unnecessarily long, whilst others might have been usefully extended. But the reader finds here abundance of useful information which no other work in the language would afford.

Geological Map of Sutherland. By M. FORSTER HEDDLE, M.D., President of the Mineralogical Society. Edinburgh: W. and A. K. Johnstone.

THIS excellent Map is the twenty-first number of the *Mineralogical Magazine*, and is arranged to fold up for the convenience of the travelling geologist, who with such a guide will find the study of the Sutherland formations much facilitated. The scale is two miles to the inch; the engraving is very clear, and, besides, the colouration showing the various leading strata, the dips, anticlinal lines, and faults are indicated.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 20, May 15, 1882.

Synthesis of Various Organic Compounds by means of the Electrolysis of Water and of Acid, Alkaline, and Alcoholic Solutions with Electrodes of Carbon.—A. Bartoli and G. Papasogli.—In researches on galvanic polarities, one of the authors had observed that coke, charcoal, or graphite, under the action of the current, is disaggregated. Whilst the electrolyte is blackened more or less according to its nature and that of the carbon, the gas evolved at the positive pole was below the normal volume. The immediate object of the present researches was to ascertain what became of the oxygen. They experimented with graphite, coke, and wood charcoal purified by treatment with chlorine at high temperatures. With coke or charcoal as positive electrode, and distilled water as an electrolyte, they had to employ a battery (=1200 Daniells) to overcome the resistance of the voltameter. After the current had passed for two days the electrolyte had a brown colour and a slightly acid reaction. The battery was then reduced to 100 Bunsen elements, and after ten days 20 Bunsens were sufficient, which acted for thirty days. The water became black, the electrode, which weighed about 500 grms., was totally disaggregated, and at the bottom of the voltameter there was a thick muddy deposit. On analysing the electrolyte there was found mellitic acid and some of its derivatives, such as the hydro-mellitic, pyro-mellitic, and hydro-pyromellitic acid. In the muddy deposit there was found a black matter, soluble in hot water and alkalies, but insoluble in most mineral acids and the majority of organic solvents. They name this substance mellogen, since, on oxidation it produces the acids of the benzo-carbonic series. Its analysis leads to the formula $C_{14}H_2O_4$.

Aperiodic Galvanometer.—MM. Deprez and d'Arsonval.—This paper cannot be intelligibly reproduced without the aid of the two accompanying figures.

Mechanism of the Putrid Fermentation of the Proteic Matters.—A. Gautier and A. Etard.—At the outset of the experiments the muscles of beef and of horse-flesh were acid and inodorous. After some days, even when the matter was entirely protected from vibrations, the muscular matter gave off an acid odour, and without disintegration emitted a clear syrupy liquid, which seemed to result from the digestion of the muscular flesh due to a peculiar ferment. This liquid, analogous to a thick serum and almost colourless, contains 21 to 22 grms. per litre of albumen, coagulable by heat, and a very minute proportion of casein. In this medium the lactic and butyric fermentations were set up under the influence of large three- or four-jointed Bacilli, of eight-jointed Bacteria, and of movable granulations. The gases given off were carbonic acid, nitrogen, and hydrogen, the two former of which increased from the seventh to the twenty-sixth day, whilst the latter decreased to a trace. There was a mere trace of sulphuretted and phosphoretted hydrogen, but no hydrocarbons. With the liberation of nitrogen the true putrid fermentation sets in. The great Bacteria and Bacilli disappear, and are succeeded by small Bacilli, and with punctiform ferments, which attack the albumenoid molecule, disengaging carbonic acid and ammonia. The great mass of the molecule passes into the state of leucines and leucines, accompanied by a small quantity of phenol, scatol, indol, and, according to the author's researches, of carbilamines and ptomaines.

A Case of Isomerism of Bichlorated Camphor.—P. Caseneuve.—The bichlorated camphor discovered is more

soluble in water than the normal kind. It liquefies on contact with chloral hydrate like camphor, which the normal kind does not. The isomer is less stable than the normal product.

Purpuro-galline.—P. de Clermont and P. Chautard. —Purpuro-galline may be obtained by exposing to the air a watery solution of pyro-gallol upon platinum black. It easily crystallises from its alcoholic solution, and forms fine needles of a deep brown colour. It melts at 256°, and sublimes with decomposition at a little higher temperature. Soda and purpuro-galline combine in alcoholic solutions, forming a sodium purpuro-gallate, which is deliquescent, very soluble in water, and if heated in a closed vessel with ethylic iodide, yields the ethylic derivative of purpuro-galline. The authors have further examined the behaviour of purpuro-galline with bromine, hydrochloric, sulphuric, and hydriodic acids, and acetic anhydride.

Dimorphism of Stannic Acid.—Michel Levy and L. Bourgeois.—Stannic oxide is dimorphous, like zirconia, and presents a crystalline variety analogous to tridymite.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 4.

Composition of the Rain and Drainage Water at Rothamsted.—Messrs. Lawes, Gilbert and Warington.—From the *Journal of the Royal Agricultural Society of England*.

Absorptive Power of Humous Media.—Dr. A. König.—The absorptive phenomena observed may be explained by the assumption of the joint action of chemical and physical processes. Humous substances appropriate alkali from alkaline solutions for the most part mechanically. The absorption increases as the moor contains less mineral matter. The absorption of potassium or ammonium from neutral saline solutions rises and falls with the mineral percentage of the moor. Chlorine and sulphuric and nitric acids appear not to be absorbed by moor soils, and phosphoric acid only in as far as mineral matter is present, with which the acid may form insoluble salts. Moor soils can absorb the water from an aqueous saline solution, rendering it more concentrated.

Manurial Experiments in Vineyards.—Dr. A. Stutzer.—In three cases out of four chemical manure gave a heavier crop than farm-yard manure. No difference was observed in the quality.

Researches on the Influence of Space on the Development and Yield of Cultivated Plants.—Prof. E. Wollny (a Continuation).—The results of the author's experiments are, seeds sown by the drill give a better return, both in quality and quantity, than those sown broadcast, and that at a smaller outlay for seed.

The Primary Effects of Light upon Vegetation.—M. Pringsheim.—The author rejects the gas-analytical method of treating this question, and prefers to observe the visible changes which the light produces in the cells within a short time, under the eye of the observer. The effects of intense light upon the plant-cell are dependent upon the presence of oxygen.

On Anhydrous Milk-Sugar, and on the Determination of Sugar in Milk.—Dr. M. Schmäger.—Solutions of milk-sugar evaporated in the water-bath leave the sugar not in its ordinary crystalline state, but anhydrous. Such, if dissolved immediately, show an abnormally feeble rotation.

Moniteur Scientifique, Quesneville.
May, 1882.

The Rosaniline Question.—A. Pabst.—It has long been known that commercial rosaniline as extracted from the product of the reaction of arsenic acid with aniline

and toluidine, is a mixture of two nearly allied bodies. M. Rosenstiehl in an investigation published about twelve years ago announced three such bodies, but since the recent researches of Fischer only two are admitted,—para-rostaniline, isomeric with the mauvaniline of Girard and De Laire, derived from a mixture of aniline and para-toluidine; the other, ortho-para-rostaniline is formed from aniline and the two toluidines. These two rosanilines co-exist in the hydrochlorate sold under the name of "fuchsine"; but one of them, ortho-para-rostaniline, is only proper for the manufacture of rosaniline blue, the other giving merely a greyish violet product. Hence manufacturers have long sought to separate them, utilising the ortho-para- for blue, and converting the para-rostaniline into magenta. The first process, employed as far back as 1855 by Girard and De Laire, consists in leaving the acetates of the bases to settle; that of para-rostaniline remains syrupy, and may be dried in amorphous crusts; that of ortho-para-rostaniline crystallises, and may be separated by draining. The solutions of the two rosanilines are closely alike; that of para-rostaniline inclines a little more to the violet, but in dyeing the shades obtained are practically identical. M. Monnet boils for two or three hours the commercial magenta with moist rosaniline prepared by precipitating a portion of the same magenta with an alkali; the para-rostaniline displaces the ortho-para- compound, and forms a soluble salt, whilst the other becomes free and remains upon the filter. After boiling in pure water it is washed in hot ammoniacal water, and serves then for the manufacture of blue. M. C. Girard gives two other methods of separation founded upon the solubilities of these bases. M. Fischer thinks that these two rosanilines are identical with the red bodies obtained by oxidising the leukanilines, which these chemists have obtained synthetically, setting out from triphenyl-methan and ortho-cresyl-diphenyl-methan. The author has expounded the ingenious theory which arranges the artificial colours in five groups: The substituted phenols, anthracene, triphenyl-methan, comprising rosolic acid, rosaniline, and its derivatives, malachite green and the phthaleines, which are the link between triphenyl-methan and anthracene; the indulines and safranines and the azo- compounds. The rosaniline may be obtained by the oxidation of a mixture of aniline and toluidine; by the oxidation of pure aniline upon stannic chloride; by the action at 150° of nitrosyl chloride upon aniline mixed with toluidine, and by the action of aniline upon nitrobenzol in presence of certain chlorides. It is very probable that rosaniline when transformed into leukaniline by reducing agents, undergoes a transformation; leukaniline and rosaniline not having the same constitution. The author does not see why there may not exist several leukanilines and several rosanilines with several rosolic acids corresponding.

Analysis of Phosphates.—A brief account of the methods adopted at the Congress of Halle in December, 1881, for fixing upon a general process for determining phosphoric acid in the different states in which it occurs in manures.

Soluble and Insoluble Modifications of the Ferment of the Gastric Digestion.—A. Gautier.—A continuation of a memoir of a physiological character.

Cadaveric Alkaloids.—A summary of the principal characters of the ptomaines.

Antiseptics.—R. Koch.—The author has endeavoured to ascertain what agents are able to destroy the spores of bacilli, how they behave towards the microphytes most easily destroyed, such as the moulds, ferments, and micrococci, and if they suffice at least to arrest the development of these organisms in liquids favourable to their multiplication. His results with phenol, thymol, and salicylic acid have been unfavourable. Sulphurous acid and zinc chloride also failed to destroy all the germs of infection. Chlorine, bromine, and mercuric chloride gave the best results; solutions of mercuric chloride, nitrate

or sulphate diluted to 1 part in 1000 destroy spores in ten minutes.

New Process for the Preservation of Meat.—The process in question is Jones's Patent and consists in the injection of a solution of boracic acid into the veins.

Note on Tincture of Iodine.—J. Casthéla. —The author proposes to obtain a permanent tincture of iodine by adding a small quantity of potassium iodide which prevents the formation of hydriodic acid.

Determination of Sulphurous Acid in Wine.—M. Haas. —From the *Berichte der Deutsch. Chem. Gesell.*

Cattle Foods and Oil Cakes.—The author strongly recommends cocoa-nut oil cakes.

New, Easy, and Economical System of rendering Wines Effervescent.—A. Carpène. —The author saturates wines, &c., with carbonic acid whilst exposed to a low temperature.

Transformation of Xanthine into Theobromine and Caffeine.—E. Fischer. —The author extracts guanine from guano, transforms it into xanthine by treatment with nitrous acid, and then converts the xanthine into theobromine or into caffeine by methylation.

Communications from the Laboratory of the Chemical School of Mulhouse.—These consist of a memoir by M. E. Noelting on certain derivatives of rosaniline; a paper by the same author on the dissociation of trichloro-sulpho-methyl chloride; and a memoir by MM. Noelting and Bourcart on the action of sulphuric acid upon protocatechuic acid.

Industrial Society of Mulhouse.—Session of March 8, 1882.—The Committee voted a medal to MM. Hofmeyer and Co., for their improvements in the purification of blood albumen.

Note on Oxalic Acid.—M. Péter, J. L. —An account of the preparation and properties of the monohydrated and trihydrated acids in a state of purity.

The Use of Zinc Chloride as a Reagent for Certain Alkaloids.—A. Jorissen claims the use of this reagent as having been first proposed by himself in the *Bulletin de l'Académie Royale de Belgique* for 1879.

Detection of the Sophistication of Olive Oil with Cotton Oil.—M. Zecchini. —The author mixes in a test-tube 5 c.c. of the oil with 10 c.c. of pure nitric acid at sp. gr. 1.40. The tube is well shaken up and left to stand for five or six minutes. Pure olive oil only takes a faint greyish brown colouration with yellowish reflections; pure cotton oil takes an intense coffee-brown, almost black. The mixtures take intermediate shades. It is necessary to operate always under the same conditions, and to observe the colours after the lapse of the time specified, and not later, as the colour of olive oil deepens on standing.

Die Chemische Industrie.
Vol. 5, No. 3.

Appendix to Prof. G. Lunge's Report to the General Meeting of the Association of German Alkali Makers.—As regards the determination of hydrogen and ethylene in gaseous mixtures, the author has devised an apparatus which takes up little more room than that of Orsat, and requires only three minutes for a hydrogen determination. In addition to the three ordinary U-tubes of Orsat's apparatus there is a fourth, which is filled with water, and serves to receive the gaseous mixture which has been passed over the combustion-capillary. The latter, filled with palladised asbestos, is introduced between the last U-tube and a special cock, so that the triple cock can subserve its ordinary purposes. A small spirit-lamp is fixed on a movable support so that it can be brought in a moment under the capillary, which should be warmed but slightly. The combination of oxygen and hydrogen or the combustion of ethylene is effected per-

fectly in a single passage through the warmed palladium asbestos, whereon the gas is driven back into the measuring tube, and its contraction is determined. Concerning the solution of pyrites there prevails still a difference of opinion as to whether nitric acid or *aqua regia* should be used. Fresenius directs "red fuming nitric acid," without specifying its exact strength. Most readers would understand the strongest acid at 1.50 sp. gr. Lefort's mixture is also mentioned, consisting of 1 part strong hydrochloric acid and 3 parts "very concentrated" nitric acid. The author has used for some time a similar mixture, the nitric acid being at 1.40. In comparative experiments which he has instituted, it appears that for opening up pyrites nitric acid at 1.42 sp. gr. should be used. Still preferable is a mixture of nitric acid of the same strength with one-third its volume of hydrochloric acid, to prevent the separation of sulphur or to promote its oxidation. As regards the determination of alkaline carbonates in presence of hydrates, where there is much caustic alkali and little carbonate (as in commercial lump caustic) titration with phenacetoline is not to be recommended, the barium chloride method being more accurate. When caustic predominates, but the quantity of carbonate is still considerable (as in caustic lye), phenacetoline gives better results, and in crude soda lyes, where the carbonate predominates, titration with phenacetoline is preferable if the lyes are not too deeply coloured. In titrating the oxidisable sulphur compounds in crude soda-lye with solution of iodine, the author prefers direct titration of the lye, which is previously much diluted and acidified with acetic acid. Prof. Lunge has examined Schœpfi's modification of Hurter's process for the titration of alkaline ferrocyanides with copper sulphate. The original process, in which oxidation is effected by means of chloride of lime, and the excess of chlorine is expelled by gentle heating, gives results not very constant or accurate, whilst sufficiently accurate results are obtained if a concentrated solution of chloride of lime or bromine water is added from a burette till drops of dilute iron chloride are no longer turned blue. A second portion is then mixed with the same quantity, it being necessary to make but few spotting tests, and is then titrated with solution of copper sulphate till a drop gives a distinct rose colour with dilute solution of ferrous chloride.

Journal für Praktische Chemie.
Nos. 5 and 6, 1882.

Reactive Value of the Components of Acids.—N. Menshutkin. —The formation of a chain of carbon atoms, and therefore the substitution of the hydrogen-valence by the carbon valence, in formic acid occasions a decrease of the speed of etherification and an increase of its limit. The magnitude of these changes is determined by the following propositions:—The formation of a chain of two carbons involves the smallest change, as in this case in acetic acid the three valences of the one carbon atom are saturated by hydrogen. The formation of a chain of several carbon atoms, setting out from acetic acid, can take place in various ways. If on one carbon atom of acetic acid one hydrogen valence is substituted by a carbon valence, as is the case in the formation of the primary acids, the speed of etherification is lessened and its limit is increased. In the formation of the normal primary acids the limit of etherification is regularly increased for each carbon atom which enters the chain. So long as the acid remains primary, complex and annular combinations are of subordinate influence. If in one carbon atom of acetic acid two hydrogen valences are substituted by two carbon valences, the speed of etherification in the secondary acids formed is still more decreased and its limit is further increased, and these changes are relatively more intense than those which occur in the formation of primary acids. The decrease of the speed of etherification and the elevation of its limit reach their

maximum when all the three hydrogen valences of the one carbon atom of acetic acid are substituted by carbon valences, as is the case in the formation of the tertiary acids.

Influence of the Molecular Weight of Homologues upon the Course of Incomplete Reactions.—N. Menshutkin.—If a reaction is complete homologues participate therein in varying proportions of weight, according to their molecular weights. Thus bromine combines with increasing weights of the homologous hydrocarbons of the ethylen series. The law of homology holds good also in incomplete reactions.

The Behaviour of Tellurium with Sulphuric Anhydride and Sulphuric Hydrates.—Rudolph Weber.—The author has examined the peculiar amethyst red compound formed when tellurium is dissolved in sulphuric acid. The compound obtained with sulphuric anhydride, TeSO_3 , is analogous to the compounds obtained under similar circumstances with sulphur and selenium.

Behaviour of Iodine with Sulphuric Anhydride and Sulphuric Hydrates.—R. Weber.—Iodine and sulphuric anhydride combine in three proportions, in which the iodine forms respectively, 34, 61, and 76 per cent.

Mercury Fulminate.—E. Carstanjen and A. Ehrenberg.—The authors examine the action of hydrochloric, hydrobromic, hydriodic, and sulphuric acids upon fulminating mercury, as also its behaviour with sodium amalgam.

Anthology of Modern Chemical Utterances.—Incapable of useful abstraction.

Hard Bronzes of Ancient Nations.—E. Reyer.—The bronzes employed for weapons and tools were free from lead and zinc, but contained in addition to copper and tin, small quantities of nickel, iron, phosphorus, and sometimes cobalt.

The Carbonic Ethers of Iso-hydro-benzoin.—M. Wallach.—This substance has the composition $\text{C}_{15}\text{H}_{12}\text{O}_3$, and melts at 110° .

Behaviour of Ortho-nitro-oxy-phenyl-acetic Acid with Reducing Agents.—Alex. Thate.—A preliminary communication. On treating the sodium salt of this acid with sodium amalgam, the author obtained azo-ortho-oxy-phenyl-acetic acid, and other bodies which he proposes to examine.

Remarks on Two Chemical Publications.—M. Nencki.—This paper consists of questions of originality and priority.

Dinitro-Compounds Obtained from Phenols.—G. Chancel.—From the *Comptes Rendus*.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 2, May 13, 1882.

Vesicular and Encyclide Crystallisation.—Dr. C. Brame.—The author concludes that the ray of influence of particular gravitation in cytogenous and encyclide crystals of vesicular origin is equal to the square root of the radius of the terminal cyclide.

Characteristic Reaction of Cotton Oil as compared with Olive Oil.—Marco Zecchini.—The author treats the oil in question with nitric acid at sp. gr. 1.40, and which must be pure and colourless. He mixes 10 c.c. of acid and 5 of oil. The two liquids are mixed in a test-tube, the mouth of which is closed with caoutchouc. It is shaken briskly for a few moments, returned to an upright position, and allowed to stand for five or six minutes. The oil then collects on the surface. If it is pure olive oil it takes a light ash-grey tint with a slightly yellowish reflection. Cotton oil, on the contrary, takes a golden yellow at once, and soon becomes of a deep coffee-brown. Mixtures of the two take intermediate shades. The observation must be made about five or six minutes after the oil and acid have been mixed, as on long standing olive oil takes a dark colour.

MEETINGS FOR THE WEEK.

TUESDAY, 13th.—Royal Medical and Chirurgical, 8.30.
Photographic, 8.

WEDNESDAY, 14th.—Microscopical, 8.

THURSDAY, 15th.—Chemical, 8. "Note on the Preparation of Amido- β -Naphthol and β -Naphtha-quinone," by C. E. Groves. "On Hematein and Brasilin," by J. J. Hummel and A. G. Perkin. "Determination of Nitric Acid as Nitric Oxide by means of its Reaction with Ferrous Salts, Part II.," by R. Warington.

Philosophical Club, 6.30.
Royal, 4.30.

TO ALKALI MANUFACTURERS.

FOR SALE, a New Filter-Press, by a first-rate maker, suitable for recovery of Magnesian Chloride in the Sulphur Recovery Process of Schaffner and Helbig. Half-price would be taken.—Apply to E. Beanes and Co., Falcon Works, Hackney Wick, London, E.

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TO BE LET, at a moderate rent, a small Works in the neighbourhood of Widnes. Gas Engine, Boiler, &c. Near railway station.—Apply to J. B. and B. Leach, St. Helens, Lancashire.

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Wanted, to Contract for the Purchase of a quantity of Redonda Phosphate.—Address, with particulars and lowest price, "Redonda," care of Chorlton and Knowles, Printers, 6, Oldham Street, Manchester.

RAINHAM, ESSEX, on the banks of the Thames.—To Bone and Chemical Manure Manufacturers, Engineers, Manufacturing Chemists, and others. Valuable Freehold Property, known as Wilson's Chemical Manure and Acid Works, in full work, and eleven cottages for workmen, extending over an area of 2 a. 3 r. 13 p. or thereabouts, together with the costly Plant and Machinery and Goodwill of the Business; also, two plots of Freehold Land, situate near aforesaid Works, together containing 5 a. 3 r. 25 p. or thereabouts, and admirably adapted as sites for the erection of large manufacturing premises; also, two Freehold Ground Rents of £20 per annum each, secured on the Works of the Gas Purification Co., with early reversions to rack rental.

M. R. ALFRED SAVILL will SELL the above Freehold Properties (by direction of the Executors) by AUCTION, at the Mart, Tokenhouse Yard, E.C., on Wednesday, the 21st June, 1882, at 2 o'clock precisely, in Five Lots. May be viewed by orders to be obtained at the Auctioneer's Offices, or at Mr. Wilson's Offices, East Ham, E.—Particulars, with plans and conditions of sale, may be obtained of Messrs. Blewitt and Tyler, Solicitors, 79 $\frac{1}{2}$, Gracechurch St., E.C.; at the Mart, Tokenhouse Yard, E.C.; and at the Auctioneer's Offices, 3, St. Helen's Place, E.C.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1177.

ESTIMATION OF ARSENIC IN COPPER.

By A. HUMBOLDT SEXTON,

Lecturer on Chemistry and Physics, Burslem and Tunstall School of Science and Art.

THE estimation of the small quantity of arsenic always present in commercial copper, or the separation of a very small quantity of arsenic from a large amount of copper, is a matter of considerable difficulty, as the ordinary methods of separation fail to give accurate results.

Having had a very extensive experience in the analysis of copper, and knowing the extraordinary discrepancies which occur in analyses of the same sample of copper by different chemists, which can only arise from the use of imperfect methods, I give the results of my experience with the various methods in use, and of a method which I devised and which I have found to give quite accurate results.

1. Separation by sulphuretted hydrogen in an alkaline solution.

It is well known that copper precipitated in this manner carries down with it a portion of the arsenic; indeed in an ordinary B.S. copper the whole of the arsenic is thus taken down. This method is therefore quite fallacious.

2. Abel and Field's method.

Abel and Field in the course of their researches on copper devised a method for the determination of arsenic and antimony, which has since come into general use, almost to the exclusion of all others, the fame of the authors having been sufficient to secure its acceptance. This method is so well known that it need not be described here, a full account of it will be found in Watts's Dictionary, vol. 11, p. 61. Suffice it to say that it is based on the precipitation of the arsenic as lead arsenate, by means of lead nitrate and ammonia and ammonium carbonate, the lead arsenate being subsequently decomposed with oxalic acid, the arsenic precipitated as sulphide, and finally weighed as ammonio-magnesium arsenate.

This method, however, notwithstanding its popularity, is not satisfactory, as it gives results always, and sometimes considerably, too low, the arsenic apparently not being completely precipitated in the first instance as lead arsenate.

3. By precipitation as basic arsenate of iron.

If to a solution containing arsenic acid, iron be added and then ammonia in excess, the acid should be thrown down completely, and I hoped that by this means the arsenic could be separated from the copper; but this method gave results far less satisfactory than the preceding. The arsenic was never completely precipitated even in presence of enormous excess of iron, sometimes as much as 10 per cent., rarely less than 3 per cent. of the arsenic remaining in solution.

4. By precipitation as basic arsenate of iron by means of sodium acetate.

After repeated experiments the following method was devised:—

The copper is dissolved in nitric acid, a small quantity of solution of ferric nitrate added, the solution nearly neutralised with sodium hydrate (not ammonia) and excess of sodium acetate added. The solution is then heated to boiling, filtered as rapidly as possible; the precipitate after being well washed is dissolved in hydrochloric acid, the solution made alkaline with ammonia and saturated with sulphuretted hydrogen and filtered from the precipitated

iron sulphide. The filtrate is acidified with hydrochloric acid and let stand in a warm place for some time. The arsenic and antimony sulphides are filtered off, dried at 100° C., the precipitates removed completely from the paper into a small beaker, treated with red fuming nitric acid, a few drops of hydrochloric acid being added as soon as the action has ceased. It is then diluted, filtered, the arsenic precipitated as ammonio-magnesium arsenate, and weighed as usual. If the precipitated sulphides cannot be perfectly removed from the filter paper, the paper must be treated with nitro-hydrochloric acid, filtered, and the filtrate added to the nitric acid solution.

I have found this method to be very accurate, and each stage has been carefully experimented upon. It requires, however, some special precautions.

When the sodium acetate is added the colour of the solution should change from pale blue to dark green; this shows that the solution has been sufficiently neutralised. The beaker must be removed from the heat immediately the solution begins to boil; if the solution be left boiling (sometimes when it is not), a greenish white precipitate of basic acetate of copper falls. This can generally be removed by the addition of a few drops of hydrochloric acid, but in cases where it has separated on the surface of the beaker, or where it will not readily dissolve, it is best to throw out the solution and commence again.

This is very troublesome to those using this method for the first time, but after a little experience has been gained it very rarely happens.

The precipitate should have the dark red colour of ferric acetate; if it is paler it is due either to there not being sufficient iron, or to the co-precipitation of some basic acetate of copper. The filtrate should be blue or pale green; sometimes it is dark green and turbid, from the presence of iron acetate carried through the filter; in that case the first portions must be passed through the filter again.

The precipitate must be washed till it is free from copper, and when it is dissolved in hydrochloric acid the solution must have the yellow colour of ferric chloride. If it is at all green, the solution must be neutralised a little more sodium acetate added, and the iron and arsenic re-precipitated.

I also made a larger number of experiments in order to ascertain the amount of iron necessary for complete precipitation. With equal quantities of iron and arsenic a small quantity of arsenic remained in solution, and the iron arsenic precipitate was of a pale colour. With 1.5 parts of iron to 1 of arsenic the precipitation was complete. In order to make sure it is well to add about twice as much iron as it is expected there is arsenic present. Then even if a little iron remains unprecipitated all the arsenic will be thrown down.

Since copper sulphide retains so much arsenic it might be expected that iron sulphide would act in a similar manner, but it does not; if there be no copper present the precipitate is quite free from arsenic, but if copper is present a considerable quantity of arsenic may be retained. Hence the importance of thoroughly washing the acetate precipitate and re-precipitating it if necessary. The antimony will be in the filtrate from the ammonio-magnesium precipitate, and may be estimated as recommended by Abel and Field, fuming nitric acid being preferable as the oxidising agent.

The arsenic may also be readily estimated by precipitation with ammonium molybdate, re-dissolving in ammonia, and precipitating as ammonio-magnesium arsenate; but in this method the antimony must be estimated in a separate portion, and that can only be done by one of the methods (2 or 4) previously described.

Pharmaceutical Society of Great Britain.—At the meeting of the Council of this Society on the 7th instant, Mr. M. Carteighe was elected President for the ensuing year.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.*

By J. W. MALLETT, F.R.S.,
Professor of Chemistry in the University of Virginia.

Need for a Re-determination of the Atomic Weight of Aluminum.

THERE is probably no one of the so-called chemical elements equally abundant in nature with aluminum, and occurring in as numerous compounds, with regard to the atomic weight of which our knowledge has long rested upon so slender a foundation of accurate experiment. The following brief statement includes, I believe, all the determinations of this constant which are on record.

Former Determinations.

1. *Experiments of Berzelius, 1812.*—Berzelius† precipitated a solution of alum by addition of ammonia, dissolved the precipitate in sulphuric acid to saturation, filtered, concentrated the filtrate by evaporation, and threw down aluminum sulphate by alcohol. This salt was well washed with alcohol, to separate as far as possible any excess of acid, and was then heated in a platinum crucible over an alcohol lamp, weighing from time to time, until no further loss of weight occurred. The anhydrous sulphate so obtained was but slowly soluble in water on heating, but left no insoluble residue. 10 grms. of this salt was now raised to a higher temperature in a weighed platinum crucible, and strongly heated as long as any loss of weight could be detected. The residue of loose, light, white alumina found in the crucible weighed 2.9934 grms. Consequently the salt consisted of—

"Sulphuric acid" (SO ₃)	..	70.066	or	100.000
Alumina	..	29.934	or	42.722
		100.000	or	142.722

Several small arithmetical errors have been made in the discussion of this single experiment of Berzelius, upon which for nearly half a century the value assigned to the atomic weight of aluminum may be said to have rested.

In the original paper it is calculated that if 42.722 parts of alumina contain 19.96 parts of oxygen (the atomic weight of sulphur being then taken = 201.16—O = 100), 100 parts of alumina must include 46.726 parts of oxygen. This last number should be 46.7207. In a later paper‡ by the same author, it is calculated from the results of the above experiment, that 100 parts of "sulphuric acid" are saturated by 42.7227 parts of alumina, and that the earth contains 46.7047 per cent. of oxygen; the earth is assumed to be Al₂O₃, and consequently the atomic weight of Al is found = 171.667 (O = 100), or 27.49 (H = 1). These numbers, correctly calculated from the percentage of oxygen taken in this second paper, should read 171.167 and 27.39 respectively. Or, if the percentage of oxygen of the former paper, corrected as above, be taken as 46.7207, the atomic weight, for Al₂O₃, will be 171.057 (O = 100) or 27.37 (H = 1).§

Finally, if Berzelius's direct results of experiment be taken, and re-calculated with Stas's atomic weights for O (15.96) and S (31.98), the atomic weight of aluminum, its oxide being assumed Al₂O₃, will be 27.237 in reference to that of hydrogen as unity.

Berzelius|| also attempted to obtain a pure hydrate of aluminum by precipitating the sulphate and nitrate with ammonia, but found that highly basic salts only were thrown down. Using the chloride instead, a hydrate was

obtained which, after being dried in the sun, gave only water on heating, but there was a little loss from mechanically-carried over alumina. This sun-dried hydrate left 64.932 per cent. of alumina free from acid. Berzelius therefore calculates that 100 parts of anhydrous alumina had been combined with 54 parts of water—this amount of water containing 47.65 parts of oxygen: while the alumina contains, as shown by the above-quoted analysis of the sulphate, 46.726 parts of oxygen. He remarks: "I cannot affirm that either the determination of the amount of water or that of the oxygen in the alumina is sufficiently exact; both are, however, so far so as to sufficiently show us that alumina, like the preceding bases, combines with an amount of water whose oxygen is equal to that of the earth itself."

In the decomposition by heat of aluminum sulphate, as thus used to furnish data from which to calculate the atomic weight of the metal, the following possible sources of error may be noticed: The hydrate precipitated by ammonia from a solution of (presumably) potash alum might carry down with it traces of fixed alkali, and this latter be retained in the sulphate afterwards prepared from the hydrate. The tendency of aluminum to form basic salts suggests the possibility of traces of sulphuric acid being lost in the preliminary drying over the simple alcohol lamp, even at a temperature at which possibly the last traces of water might not have been removed. I have found from my own experiments that a trace of basic sulphate may, on the other hand, be obstinately retained even after prolonged exposure to a very high temperature, when it might be assumed that pure alumina alone was left. As Berzelius himself says, ignited alumina rapidly absorbs moisture from the air, involving risk of error in determining its weight. Traces of the light pulverulent alumina are liable to be mechanically carried away during the decomposition of the sulphate. It is observable that all these sources of error, except the last, tend in the same direction, to make the atomic weight of aluminum come out too high.

2. *Experiments of Sir Humphry Davy, 1812.*—In Sir Humphry Davy's "Elements of Chemical Philosophy,"—published in 1812, the same year in which Berzelius's first paper on this subject appeared—it is stated* that no direct researches had then been made on the quantity of oxygen in alumina, but that, from some experiments by the author on the quantity of ammonia required to decompose saturated solutions of alumina in acids, "it would appear that the number representing alumina is about 48, and, supposing it to consist of one proportion of aluminum and one of oxygen, 33 will be the number representing aluminum." The details of the experiments in question are not given, and the combining proportions of all substances having been very imperfectly known at the time—the number 15 is taken above for oxygen—it is needless to say that this passage throws no light upon the exact atomic weight of aluminum.

3. *Experiments of Thomson, 1825.*—Thomson† attempted to deduce the number representing this atomic weight from, (a) analyses by himself and others of sundry natural aluminous silicates, (b) analyses of potassium alum, and (c) analyses of hydrates of aluminum. He concluded from all his experiments that the true number for alumina is 2.25 (O = 1), and, taking alumina to be AlO, he made Al = 1.25. This corresponds to Al = 30, if O be assumed = 16, and alumina Al₂O₃—a result which can only be viewed as a rough approximation to the truth, since Thomson's methods were far from accurate, and his experimental results agree but poorly with each other.

4. *Experiments of Mather, 1835.*—W. W. Mather,‡ Assistant Professor of Chemistry at the United States Military Academy, West Point, prepared anhydrous alu-

* From the *Philosophical Transactions* of 1880. Paper read before the Royal Society, April 22, 1880.

† Gilbert's *Annalen der Physik*, 40 (1812), 260.

‡ Poggendorff's *Annalen der Physik u. Chemie*, 8 (1826), 187.

§ A. C. Oudemans, jr. (In his "Historisch-kritisch Overzicht van de Bepaling der Equivalent-Gewigten van twee en twintig Metalen; Leiden, 1853), calculates, from Berzelius's figures, Al = 171.02.

|| Gilbert's *Annalen*, loc. cit.

* Vol. 4, 263, of the *Collected Works of Sir H. Davy*, edited by his brother Dr. John Davy, London, 1840.

† Thomas Thomson, M.D., "An Attempt to Establish the First Principles of Chemistry by Experiment," 1, 285; London, 1823.

‡ Silliman's *American Journal of Science and Arts*, 27 (1835), 241.

minum chloride by Wöhler's process, dissolved a weighed portion of it in water, added silver nitrate in excess, filtered off, dried and weighed the silver chloride formed, threw down excess of silver from the filtrate by hydrochloric acid, filtered again, evaporated this second filtrate and washings to dryness, ignited the residue, and weighed it as alumina. 0.646 grm. of aluminum chloride gave 2.0549731 grms. of silver chloride (yielding on reduction 1.548161 grm. of silver) and 0.2975 grm. of alumina.

From the amount of silver chloride found and silver obtained from it in this one experiment, and from the atomic weights of silver and chlorine adopted by Berzelius and Thomson respectively, Mather calculated values for the atomic weight of aluminum ranging from 1.82274 to 1.85430 ($O=1$, and the formula of the chloride being taken as $AlCl_3$), or 29.16384 to 29.66880 for $O=16$; but from the amount of alumina obtained and the amount of aluminum therein (the latter deduced from the chloride taken for analysis minus the chlorine found), he calculated the atomic weight for aluminum as 1.3188017 ($O=1$) for alumina taken as Al_2O_3 , or 21.1008272 for $O=16$. He does not seem to have been struck by the evidence of some error in his own work which these discrepant numbers afford, but suggested that the figures given by Berzelius for the aluminum and oxygen in alumina might have been accidentally inverted, which would explain the disagreement between himself and the great Swedish chemist. In reality it is pretty plain that Mather's alumina was not pure, either from fixed matter of some kind left behind from the acids and wash water used, or from absorption of moisture before weighing. If his most direct result only be taken as the basis of calculation, namely, the weight of aluminum chloride used and silver chloride obtained from it, using Stas's numbers for chlorine (35.37) and silver (107.66), the atomic weight of aluminum found will be 28.778 for the formula $AlCl_3$.

5. *Experiments of Mallet, 1857.*—In 1857 the writer of this paper attempted to use metallic aluminum, which had not long before begun to be manufactured and sold, for the determination of the atomic weight. At the meeting of the British Association held in that year at Dublin,† he gave a brief account of his experiments, which had been made with the metal of commerce, containing, as he found, only from 93 to 96 per cent of pure aluminum. The exact nature and amount of the foreign substances present, chiefly iron and silicon, having been determined, the crude metal was dissolved in hydrochloric acid, the solution precipitated by ammonia, and from the amount of alumina left from the precipitate on ignition, after allowing for the impurities, the atomic weight was deduced. The results obtained from a few experiments were not satisfactory enough to warrant any proposal to modify the then received number. The probability that this number needed correction, was, however, pointed out, with reasons for such an opinion; the desirability of obtaining for the purpose of new experiments really pure metallic aluminum was noticed; and it was suggested that difficulties connected with the accurate determination of alumina by the method which had just been tried might make it eligible to determine instead the hydrogen given off during the solution of the metal in acid.

(To be continued.)

Determination of Lead Peroxide.—H. Fleck.—The author decomposes the peroxide with hydrochloric acid, conducts the chlorine into a solution of potassium iodide, and titrates the iodine set at liberty.—*Journal de Pharmacie et de Chimie*.

* The seven decimal places are given, notwithstanding the statement by the author himself that his balance could weigh easily 1-300th grain, and was sensible to 1-700th grain.

† Report of British Association Meeting at Dublin, 1857; "Transactions of Sections," 33.

ACTION OF INSOLUBLE METALLIC SULPHIDES UPON A SOLUTION OF ACID NICKEL SULPHATE IN PRESENCE OF SULPHURETTED HYDROGEN.

By M. H. BAUBIGNY.

If the progressive formation of nickel sulphide in a solution of the sulphate of this metal containing sulphuretted hydrogen is a function of the relation of the weights of the acid and of the metal present, as I have announced it is, because the precipitated sulphide, *i.e.*, the insoluble body, intervenes in the reaction of the compounds still in solution, it results from this hypothesis that (1) if we take away at any given moment the sulphide existing from the medium formed by the solution of nickel sulphate, the reaction must stop; (2) if to a solution of the acid sulphate of nickel we add a quantity of the sulphide of this metal, such that the weight of the free acid and that of the metal added in the form of sulphide are in the proportions of weight necessary to form a neutral or feebly acid sulphate, the nickel in solution must be progressively precipitated as sulphide.

If from a solution of neutral nickel sulphate (1.100 grm. in 140 c.c. of water), and saturated at 0° with sulphuretted hydrogen we remove after some hours by filtration the sulphide deposited, the solution will not give any further precipitate of sulphide if exposed anew at the ordinary temperature, even if care be taken to re-saturate it at 0° with sulphuretted hydrogen before closing the vessel. This first result was easy to foresee, for we may consider the liquid separated from the sulphide as constituting a new initial state, that of a solution of acid nickel sulphate. It is equally true that nickel sulphide, if placed in a solution of acid sulphate of the same metal, identical to that from which it has been separated by filtration, re-establishes the former conditions. In any case the state of the sulphide employed has its importance. The crystalline and compact sulphide, as obtained under certain conditions, of which hereafter, is inactive, or at least took no effect in the course of fifteen days. Nickel sulphide does not act by its presence, like a porous body, but chemically.

If we substitute for the nickel sulphide zinc sulphide in the same state of division, and operate otherwise under the same conditions, the totality of the nickel sulphide remains in solution even after a month of action. Copper sulphide, on the other hand, acts like nickel sulphide. If to a solution of 0.731 grm. nickel sulphate in 140 c.c. of water we add any given weight of neutral copper sulphate—1.500 grm. for instance—and saturate it with sulphuretted hydrogen gas before closing the vessel, then in spite of the relatively considerable quantity of acid set at liberty from the formation of copper sulphide, there remains in the liquid eight days afterwards merely 0.440 grm. nickel sulphate.

In a solution of neutral sulphates containing merely zinc and nickel sulphuretted hydrogen cannot precipitate nickel sulphide along with the zinc unless the weight of the zinc is much less than that of the nickel—about one-third according to the author's former observations. But it can in any case be prevented by adding a little free acid to the solution.

With copper, on the contrary, nickel may be precipitated whatever may be the proportions of weights of the two metals, nickel and copper, if we operate with neutral sulphates, and this precipitation can be effectually prevented only by the addition of free acid in sufficient quantity. Further, when the precipitation is once begun, it must be conducted rapidly and without interruption, and the first washings in the same manner; for notwithstanding the previous addition of an excess of free acid the conditions of the medium changing constantly during filtration, as well upon the filter as in the beaker, there comes a time when the copper sulphide and the small quantity of liquid which still moistens it are in such proportions in this

medium that the totality of the weights of the two metals, copper and nickel, bears the same proportion to the totality of the acid, free and combined, as in a neutral sulphate, conditions in which the copper sulphide can act upon the nickel sulphide. If these conditions are too much prolonged the analysis becomes necessarily inexact.—*Comptes Rendus*.

ANALYSIS OF INDIAN BREWED AND OTHER ALES.

By C. J. H. WARDEN,
Bengal Medical Staff, Chemical Examiner to Government, &c.

THE following is a tabulated statement of the composition of twelve samples of Indian brewed, and five samples of imported beer. The samples were received from the Commissariat Department in sealed bottles:—

Place of Manufacture, &c.	Specific Gravity at 15° C.	Proof Spirit by Volume.	Extraction p.c. dried at 100° C.	Malt in lbs. per Gallon.	Total Acidity as (C ₂ H ₃ O ₂) per cent.	Ash per cent.
<i>Ale</i> .—Dyer and Co., Simla	1007.91	13.87	4.75	2.491	0.192	0.240
"East India Pale," Whymper and Co., Mussorie..	1011.11	12.1	5.41	2.377	0.288	0.43
Munee Brewery Co.	1008.11	15.03	4.63	2.659	0.198	0.25
"Troops Ale," Nyna tal Brewery Co.	1011.11	11.8	5.07	2.32	0.192	0.39
"India Pale Ale," Mackinnon & Co., Mussorie ..	1010.39	12.9	4.65	2.473	0.168	0.25
"Canteen issue," Meakin and Co., Kasauli .. .	1012.43	11.2	5.39	2.293	0.144	0.21
<i>Porter</i> .—"Canteen issue," Meakin and Co. .. .	1016.55	11.92	6.67	2.551	0.246	0.38
Whymper and Co.	1015.23	12.7	6.57	2.642	0.300	0.42
Mackinnon and Co.	1010.91	11.6	5.52	2.314	0.336	0.35
Nyna tal Brewery Co.	1010.15	10.7	4.59	2.14	0.228	0.22
Munee Brewery Co.	1010.63	10.8	5.46	2.213	0.36	0.35
Dyer and Co., Simla.	1012.48	13.4	5.31	2.641	0.276	0.23
"Tivoli Beer"	1014.43	10.2	6.44	2.198	0.228	0.27
"Anglo-Bavarian Beer"	1001.63	11.0	2.57	1.843	0.21	0.31
"Pilsener Beer"	1006.07	8.3	3.19	1.563	0.12	0.06
<i>Imported English Ale (Cask)</i> .—						
Taylor, Walker, and Co.	1004.39	11.0	3.25	1.970	0.306	0.27
" " " (Porter)	1005.75	11.92	3.67	2.117	0.288	0.14

The extractive matter was calculated in weighed quantities of the samples. In determining the amount of malt used per gallon no deduction was made on account of loss of gravity from acetic acid.

Medical College, Calcutta, April 24, 1882.

ON THE DETERMINATION OF CHLORINE IN PRESENCE OF BROMINE AND IODINE.

By G. VORTMANN.

MM. C. L. Müller and G. Kircher have recently published in the *Berichte der Deutschen Chemischen Gesellschaft* certain experiments on the behaviour of peroxides with chlorides, bromides, and iodides in presence of free acetic acid. On the faith of these experiments they maintain that the author's method of separating chlorine from bromine and iodine (*Berichte*, xiii., 325) is not trustworthy. A full description of the process appears in the May number of the *Vienna Monatsheft*, and in the meantime the author seeks to explain how MM. Müller and Kircher have arrived at results differing so widely from his own. As regards the fact that on boiling potassium chloride, lead peroxide, and acetic acid a perceptible escape of chlorine, and consequently a loss of hydrochloric acid, occurs, his observations agree with those of the chemists

just named, provided the concentration of the acid exceeds 5 per cent. He has observed, however, that not a trace of potassium chloride is decomposed if acetic acid of only 2 to 3 per cent is used, and the evaporation is conducted upon the water-bath, even when the evaporation is repeated five or six times; under which circumstances potassium iodide is easily decomposed and potassium bromide less readily, but still in small quantities, completely if the evaporation is repeated two or three times. The same holds good with the action of manganese peroxide and acetic acid upon potassium bromide. Whilst acetic acid at 2 or 3 per cent decomposes potassium iodide in presence of manganese peroxide very easily the first or second time of evaporation, the same mixture has no action upon potassium bromide, and acetic acid at 10 per cent must be used to liberate even traces of bromine. The author promises to publish the details of analyses showing that his method is not merely accurate but in many cases very convenient.—*Berichte der Deutschen Chemischen Gesellschaft*.

THE MOST CONVENIENT SCALE FOR A THERMOMETER USED IN GAS ANALYSIS.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

It is impossible to dispense with a thermometer in gas analysis, if accuracy and rapidity of work are both required. No method of keeping the temperature constant, nor of mechanically compensating for its variations, answers this double requirement. My analyses of air are made with a probable error of but the four-hundredth part of one per centum. In them the total reduction of the whole analysis, that is the computing the percentage of oxygen from the readings of scale and thermometer, takes less than two minutes and a half. No system other than that which determines the temperature, and corrects for its variations, can equal this in rapidity.

If the thermometer is to be used in gas analysis, it is worth while to provide it with that form of scale which is most economical of time. Usually it is necessary to read the centigrade degree on its scale, and then consult a table for a logarithmic factor corresponding; the thermometer ought to be so graduated as to show this logarithm directly, dispensing with the table.

A seeming difficulty lies in the fact that the degrees are of varying length, and hence not so easy to produce on a

* *Proceedings of the American Association for the Advancement of Science*, vol. xxix., Boston Meeting.

graduating engine. But since all that is required is that the graduations shall show logarithms accurate in the fifth decimal place, the difficulty can easily be surmounted. We may compute the places on the centigrade scale at which every third logarithmic degree would end, and then divide these intervals of three logarithmic degrees into thirty tenths at one setting of the engine. No error would appear in the fifth decimal place in this way. As the logarithmic degrees mentioned are two-thirds as long as centigrade degrees, the number of settings of the engine, to reach say thirty-five degrees, would not be too troublesome.

The most convenient method of numbering these logarithmic degrees may be described. The freezing-point should be considered as corresponding to the logarithm of unity; at about sixteenths of a centigrade degree above this point will be a logarithm differing from the former by one-thousandth; the space between this and the former is to be divided into ten equal parts, which represent units of the fourth place of decimals, and read by estimation to units of the fifth place of decimals. This logarithm differing by one-thousandth from the logarithm of unity should be numbered 99, representing the logarithm 0.99900. At about 1.2 centigrade will stand logarithmic degree 98, representing logarithm 0.99800. The scale is continued upwards in this way, the numbers decreasing upwards. The number taken from this scale, followed by the tenths and hundredths, and preceded by the figure nine, supplied mentally, is the logarithm to be added to the logarithms of tension and observed volume to reduce apparent volumes at other temperatures to the freezing-point.

REMARKS ON JOLLY'S APPARATUS FOR DETERMINING THE AMOUNT OF OXYGEN IN AIR.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

This apparatus resembles Jolly's air-thermometer. The air to be analysed is contained in the bulb of the apparatus, and is measured by determining its tension at the freezing-point. Its oxygen is absorbed by a spiral of copper wire heated by an electric current, and the residual nitrogen is measured at the freezing-point. The process is simple, and the apparatus is simple and economical; but it can claim no greater accuracy than has been obtained by a great many experimenters by means of the more rapid process with eudiometric apparatus.

Let us compare its accuracy with the accuracy of the Bunsen long eudiometer, and that of the Franklin and Ward apparatus. We compute the probable error of Jolly's apparatus on the hypothesis that the probable error at the so-called Jolly point is the hundredth of a millimetre, and that at the other three measurements is the tenth of a millimetre. This probable error of the result may be compared with the probable error computed for the two other apparatus on the hypothesis that the probable error in each reading is the same quantity as that in the corresponding kind of reading in the Jolly apparatus, namely, the tenth of a millimetre.

The error at the Jolly-point is partly one of volume observed, and partly of tension observed. The two have always the same sign, and form but one independent error. The error at the top of the manometric column, and the errors at each end of the barometric column, form the other three independent errors to which the measurement is liable. Their total effect makes the probable error of the measurement 0.023 per centum.

The volume of air taken for analysis enters the result as a denominator and as a minuend in the numerator. These

two effects have contrary signs, and the residual effect is four-fifths of the probable error of the measurement. The probable error of the other measurement of residual nitrogen enters the result with its full value. Their joint effect makes the probable error of the result 0.029 per centum.

Now in the eudiometric process, the error in the measurement of air enters the result only as a divisor, with one-fifth its value. The measurements before and after explosion affect the numerator with one-third their value. All the errors of measurement are diminished threefold and fivefold in their effect on the result. The errors probable in the result with the Bunsen long eudiometer and with the Frankland and Ward apparatus are 0.027 and 0.019 per centum, for a probable error of a tenth of a millimetre in each scale reading. Therefore, while a Jolly apparatus can make more accurate single measurements than the other methods, it is not capable of obtaining so accurate final results.

If the apparatus be modified, as the air thermometer has been modified, by closing the end of the manometer tube, and dispensing with the barometer, the apparatus will give as good results as the Frankland and Ward apparatus. The probable error of a measurement becomes 0.014 per centum, and the probable error of the result 0.019 per centum, both on the hypothesis of a probable error of a tenth of a millimetre in each scale reading and of a hundredth at the Jolly-point.

The following table shows the probable comparative errors of the four apparatus mentioned:—

	Bunsen long Eudiometer.	Frankland & Ward apparatus.	Jolly apparatus.	Jolly apparatus modified.
	P.c.	P.c.	P.c.	P.c.
Probable error—				
1st measurement	0.045	0.034	0.023	0.014
2nd measurement	0.059	0.042	0.023	0.014
3rd measurement	0.048	0.033	—	—
of result	0.027	0.019	0.029	0.019

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, June 10th, 1882.

Prof. CLIFTON, President, in the Chair.

NEW member—Major-General Martin, R.E.

Mr. W. F. STANLEY read a paper on "Sonorous Vibrations," especially those of the tuning-fork. The larger and more visible movements of a sounding body do not appear to be best fitted to propagate musical sounds, as was shown by placing disks on the prongs of a powerful fork, which, when vibrating, could then only be heard a short distance, whereas by its smaller longitudinal motions when placed on its resonator it produced a penetrating sound. The vibration down the stem of the fork was shown not to depend upon a vibrating ventroid, as suggested by Chladni, for a fork cut in the end of a solid steel bar communicated sonorous vibrations equally well to the resonator. To set a fork in vibration it was necessary to bow one prong only; therefore, in this case, the vibration must proceed along the prongs. A light fork, 1 metre long, was fixed in a heavy vice, and it was shown by it that vibrations passed down one prong and up the other alternately. By means of dust, ripples were shown to run down an ordinary fork in vibration. Light pieces of metal were fitted to the ends of a powerful fork and the immersed in mercury, the reflected surface of which

* Proceedings of the American Association for the Advancement of Science, vol. xix., Boston Meeting.

shown on a screen, where it was seen that the whole mercury surface was broken into fine ripples. It was suggested that such small waves are also perceived by the ear. By these, certain conditions of harmonics could be better accounted for, as, for example, by division; in smaller waves the rarefaction of a note in space would not suffer interference by the condensation of its octave falling in the same space and time.

Lord RAYLEIGH explained several of Mr. Stanley's experiments on the known theory of sound.

Mr. WALTER BAILY then exhibited a model of a "*New Integrating Anemometer*." This apparatus contains a horizontal plane, in which are two slits, forming a cross, with arms towards the cardinal points. Each slit is fitted with a sliding piece, and the two slides are connected by a bar, the arrangement being that of the well-known instrument for drawing ellipses. The slides carry beneath them, wheels, with their planes perpendicular to the slits and passing through the pivots of the bar. The wheels rest on a horizontal disk, whose centre is beneath the centre of the cross. The centre of the bar is to be connected to a weathercock, which will keep it in the direction of the wind when looked at from the centre of the instrument. The disk is to be revolved by Robinson's cups. The number of revolutions of the wheels then give the integral of the resolved parts of the wind in the direction of the cardinal points. In the working model of the instrument exhibited there was an electrical arrangement connected with four indicators, one for each of the cardinal points. At each turn of a wheel a circuit was completed, and the corresponding indicator moved. Recording instruments are to be substituted for indicators, and the amount recorded on each in a given time will be proportional to the total motion of the wind towards the corresponding cardinal point.

Mr. LECXY pointed out that a good anemometer was a great desideratum at present.

The Society meets at Oxford on the 17th, and South Kensington on the 24th of this month.

NOTICES OF BOOKS.

Dyeing and Tissue-Printing. By W. CROOKES, F.R.S. (*Technological Handbooks.* Edited by H. TRUEMAN Wood, Secretary of the Society of Arts.) London: G. Bell and Sons.

THOSE of our readers who have taken an interest in the City and Guilds of London Institute for the Advancement of Technical Education will be aware that the want of a series of manuals specially adapted for the use of students preparing for the examinations of the Institute soon made itself felt. On the tinctorial arts, for instance, there certainly existed important and valuable treatises. But they were for the most part too costly for students, many of whom would probably be of limited means. Other works, again, were unsuitable because they did not begin at the alphabet of the arts in question. What was needed, therefore, was a handbook, not too costly, plain, and simple in its style, covering the whole ground, and making no special demands upon the previous knowledge of the student. Mr. Crookes has undertaken the somewhat difficult task of drawing up such a work, and appears to have succeeded in fulfilling the various conditions above laid down. The only previous qualification of which the student is assumed to be possessed is an elementary knowledge of chemistry, such as may be acquired from almost any of the rudimentary treatises on that science. The author, building upon this foundation, seeks to explain the principles of the art from a practical rather than from a theoretical point of view. From the very outset he endeavours to explain everything with which the learner might be puzzled. In the preface there are

given explanations of certain measures used in dye-works, &c., and little known elsewhere. In the "General Introduction" the first point brought forward is the cleansing of the goods to be operated upon—a matter in which even experienced dyers are often sadly indifferent, and thus insure an unsuspected source of blunders, which are charged against the dye-wares or the mordants, and which can often be rectified only by the expenditure of much time and trouble. Mr. Crookes even demands, as far as is humanly possible, chemical purity in the vessels used, in the materials to be dyed, in the water, and in the dye-wares. We know that good results are often produced without the observance of these conditions, but we know also that a prudent man will, if possible, avoid the risk. Half the skill employed in "cobbling" pieces which have come up spotty, or flat, or smeary, would have prevented these evils, and given a far better result.

At this part of the treatise a description is given of the procedures for bleaching the different textile fibres, that is, freeing them from their natural colouring-matters, which in many cases if let remain would be as fatal as artificial dirt.

The next section, on the selection of water for dye- and print-works, has been evidently written with great care. The author points out what kinds of water are needed, from what geological formations it may best be obtained, and what possible ingredients are to be especially avoided. It may here be remarked that the water needed for tinctorial purposes, and, indeed, for the industrial arts generally, is not the same quality as that which sanitary reformers demand for domestic purposes. For dietetic purposes the presence of salts of lime, and even of magnesia and iron, to a moderate extent, is not objected to. For the dyer or the printer, iron is fatal, and compounds of calcium and magnesium greatly interfere with many of his operations. Processes are given for the detection of the ordinary impurities, and for their removal, when necessary, upon the large scale.

Next follows a chapter on mordants. Here the author enters a little more into theoretical considerations than in most parts of the work. He shows that if the action of the metallic mordants and the nature of the aniline colours had been better understood, practical men might have been saved the trouble of tedious attempts to fasten, e.g., magenta upon cotton fibre by means of aluminium acetate or sulphate. Surely, even those who talk most loudly of the uselessness of what they are pleased to brand as mere "book-knowledge," might see the necessity of having some acquaintance with the properties of the agents they use. To argue that because magenta is a red colour it must be capable of fixation in the same manner as cochineal is not, after all, a very practical procedure. The instructions for the preparation of nitrate of iron rank among the fullest which have ever been printed, and speak of close and extensive observation.

The accounts of the astringents, of the fatty and the animal mordants—commonly so-called—are exceedingly thorough going.

In the "General Instructions on Dyeing" we find not a little matter which it is probable has never appeared in print before, having probably been overlooked as too elementary. Among other needful matter we find here the introduction of certain technical terms, which would greatly perplex the tyro on his introduction to practical work. Here, also, are plain directions for "matching off" colours, i.e., for comparing the goods dyed with the pattern sent as a standard.

After these general and introductory considerations, follow a series of receipts for obtaining different colours upon cotton. It has evidently been the author's object to exemplify the methods required for dealing with cotton in its different states, such as cotton-wool, yarns, piece-goods of various kinds, such as calico, cotton-velvet, cords, &c., and to show the processes for applying the new colours.

After, cotton, linen, jute, wool, and silk, are worked

through in a similar style, the characteristic features of each staple being noticed in a few preliminary remarks.

The latter half of the book is devoted to tissue-printing in its various styles and branches. It cannot be denied that the work would have been more useful had it been illustrated with dyed and printed patterns, diagrams of machinery, &c. But such additions would have involved such an increase in the price of the book as to be out of the question. For the purpose in view this treatise will form a sound and useful basis for the student.

The Laboratory Guide, a Manual of Practical Chemistry for Colleges and Schools, specially arranged for Agricultural Students. By ARTHUR HERBERT CHURCH, M.A., of Lincoln College, Oxford, Professor of Chemistry in the Royal Academy of Arts, London. Fifth edition, revised and enlarged. London: John Van Voorst.

ON comparing the present edition of Prof. Church's Laboratory Guide with its earlier phases, we cannot fail to be struck with the great changes which have been made. Whilst the general plan of the work has been retained, and whilst none of the features which won for it the general approval of teachers and students have been sacrificed, additions and improvements have been numerous. As instances, the reader may compare the instructions here given for the determination of nitrogen with those laid down, say, in the second edition. Not only is the space devoted to this important process doubled—the precaution of adding an excess of pure dry starch to such substances as hair, wool, and albumen, is recommended, and Ruffie's thiosulphate process is fully described and recommended for the substances which do not yield the whole of their nitrogen as ammonia when burnt with soda-lime in the ordinary manner.

The chapter on the analysis of drinking-water has also been greatly enlarged and modified. It is very satisfactory that Prof. Church does not consider that the character of a water can be deduced from two or three data alone, but considers it advisable to ascertain the presence or absence of phosphoric acid, to observe the action of the water on lead, to apply Heisch's sugar-test, and to submit the deposit to microscopic examination. He does not refer to the presence or absence of free oxygen, which is in some cases an important feature.

The instructions for the determination of the albumenoids in articles of diet, form an exceedingly useful addition in the present volume as compared with the earlier additions. Until a comparatively short time ago it was believed that the nutritive value of any root, leaf, &c., could be discovered by a simple determination of its total nitrogen. It is now known that nitrogen can and does exist in forms in which it is not capable of assimilation by the animal system. Hence a determination of the albumenoids becomes necessary. Two methods for this purpose with carbolic acid and with copper hydrate are accordingly given.

Prof. Church's work as it stands is undoubtedly the best laboratory guide which can be put into the hands of the agricultural student,—a class whose requirements extend far beyond that mere valuation of manures and soils of which they are popularly supposed to consist.

The Pharmacopœia of the London Hospital: Compiled under the Direction of a Committee appointed by the London Hospital Medical Council. London: J. and A. Churchill.

THERE is but little matter in this Pharmacopœia which can fully fall within the cognizance of the CHEMICAL NEWS. There is in the first place a list of the medical and surgical staff of the Hospital. Then follows the materia medica, in which we merely notice a case where pharmaceutical nomenclature differs somewhat perplexingly from

that of pure chemistry, i.e., calx chlorata, which from the context must evidently mean calcium hypochlorite, but which might easily be understood as calcium chlorate. The formulæ for adults and for children call likewise for no remarks from our point of view.

In the instructions for case-taking in the children's ward we note with interest that the Clinical Clerk is required to record whether the patient has been fed upon farinaceous foods. But for the Libel Laws, which may be truly called the quack's shield, these preparations and at least nine-tenths of the so-called patent medicines would have long been swept out of existence.

Next follows a figure and description of Dr. Dupré's apparatus for the determination of urea by the sodium hypobromite process, an account of the determination of sugar in urine by Fehling's process, and a list of solutions for preserving and staining animal preparations.

Then follows a chapter on poisons and their antidotes. It is remarkable that the compounds of chromium are omitted, since, from their extensive use in the arts, they may be accidentally introduced into articles of food or drink. The rest of the book is taken up with a list of the abbreviations used in prescribing, metric weights and measures with their equivalents in the weights and measures of the British pharmacopœia, and tables of doses.

Household Chemistry for the Non-chemical. By A. J. SHILTON, F.C.S. London: F. V. White and Co.

THIS is a work which strongly reminds us of the late Professor Johnston's "Chemistry of Common Life." The writer, indeed, admits in his preface that many books have been written on the chemistry of things commonly met with in daily life, but contends that they have been at fault "in at least one particular," i.e., in containing a quantity of matter "not of a strictly chemical nature, and which, however interesting in itself, swells the book to a large size without adding to its usefulness." It might perhaps here be remarked that matter not strictly chemical may yet be very useful, and may be legitimately introduced into works of a popular class. Indeed, in describing, as the author proposes to do, "certain chemical principles and processes involved in some household operations," it will not always be found easy to eliminate physical and physiological considerations.

Mr. Shilton devotes his first chapter to "chemical preliminaries." In the second he treats of washing soda, common salt, and other sodium compounds, and describes briefly the alkali manufacture. The manufactures of soap and of candles are next sketched. As regards the latter subject it may be asked whether, as the processes of candle-making are mainly mechanical, the author is not, like his predecessors, introducing matter which is "not of a strictly chemical nature."

Ozone, though it figures as an item on the cover of the book, is but slightly noticed in the text. We are glad to find that the author shows himself sceptical as to the alleged wonderful powers ascribed to this compound. He is even hard-hearted enough to inform the British public that the peculiar odour which they greedily inhale at the seaside and regard as a panacea consists principally of the effluvium of "decomposing crabs and seaweed." As regards the proportion of carbonic acid in the air, the chief weight is still laid, as in older manuals, upon its production by the respiration of animals and by combustion, and on its decomposition in the nutrition of plants. But we find no mention of a pair of processes which are at work on a probably larger scale, i.e., on the one hand the exhalation of carbonic acid from volcanoes, and on the other, its withdrawal from the atmosphere in the form of calcium carbonate by certain processes of marine animal life, especially by the coral-worms.

The chapter on water contains some very sound advice, and we are glad to perceive that the author gives his vote for soft water as the more suitable for domestic purposes.

The cost of softening a hard water by dint of soap is given as £47 1s. 8d., as against 8d. for doing the same work by Clark's process. A section on disinfectants, though correct in its statements, does little more than show how very limited as yet is man's power of dealing with disease germs.

Succeeding chapters deal with starch, the sugars, the manufacture of bread, though without any reference to the ultra-filthiness of our modern town bakeries, fermentation, distilling, wines, where the "plastering" fraud is duly denounced, vinegar, the infused beverages, the glass and porcelain manufactures, and the chemistry of food. As the entire compass of the book falls short of 200 pages, not very closely printed, it need scarcely be said that these subjects can be but briefly dealt with. The author, however, may fairly be said to have made the best of his narrow space, and to have given a clear summary of his subjects.

Smithsonian Miscellaneous Collections, 441. *The Constants of Nature*. Part V. *A Re-calculation of the Atomic Weights*. By FRANK WIGGLESWORTH CLARKE, S.B., Professor of Chemistry and Physics in the University of Cincinnati. Washington: Smithsonian Institution.

INQUIRIES concerning the atomic weights are of the highest importance. Until their values are determined in a manner which excludes all appreciable error, the fundamental questions as to their nature, their possible origin, and their decomposability cannot even be discussed in a fruitful spirit. Great gratitude is therefore due to Prof. Clarke for the systematic re-calculation which he has here undertaken. His object has been to bring together all existing trustworthy data, to reduce them to common standards, and to determine the probable error for each series of figures. By so doing he has cleared the ground for future experimenters, who can now clearly see what remains to be done, and has thrown a light on the relative values of different lines of research. He complains, and with full reason, that in many series of determinations of the atomic weights of elements, it has been neglected to reduce the weighings to a vacuum standard. Errors have thus been introduced; slight and possibly capable of being in many cases safely neglected, but in other instances serious. As another vitiating feature in many otherwise admirably conducted determinations, the author, following Dumas, points to the occlusion of oxygen by silver.

Passing to the various elements he finds from a discussion of the results of Erdmann and Marchand, Dumas, Boussingault, and Regnault, the mean atomic weight of oxygen = 15.9633, with a probable error of ± 0.0035 .

The atomic weights of the group silver, potassium, sodium, chlorine, bromine, iodine, and sulphur are so closely dependent upon each other that they can scarcely be considered separately. The author finds the general mean results ($O = 15.9633$) as Ag, 107.675; Cl, 35.370; Br, 79.768; I, 126.557; Na, 22.998; K, 39.019, and S = 31.984. If these values are re-calculated on the basis $O = 16$, they differ from the results of Stas, by fractions of which two only affect the second decimal place. As Prof. Clarke observes, "no other criticism could more severely test the character of Stas's work, or more definitely illustrate his magnificent accuracy."

In the appendix the author examines the bearings of the most recent determinations upon Prout's law. It is very significant that in the silver group of which we have just been speaking the "Dumas correction," i.e., consideration of the oxygen occluded by silver, tells in favour of Prout's hypothesis in five out of the seven cases, leaving one value unaffected and rendering one only less in harmony with the demands of the hypothesis. The question is naturally raised: Have we here in the case of silver an exceptional phenomenon, or do other metals used in the determination of atomic weights occlude, possibly, gaseous impurities. The author refers again to

general sources of error. Thus, if oxygen = 16 instead of 15.9633, the atomic weight of uranium is affected to the extent of 0.548. The atomic weight of carbon depends upon that of oxygen; that of calcium upon carbon and oxygen; that of fluorine upon calcium, carbon, and oxygen as well as upon sulphur, silver, and chlorine.

The author quotes Prof. Mallet's argument in favour of Prout's hypothesis. Taking the atomic weights of eighteen elements, which seem well determined, he shows that ten of them have values which approach whole numbers within 1-10th of a unit. He then asks, what is the mathematical probability that this close approximation to Prout's law in ten cases out of eighteen is purely accidental, as those chemists who reject the hypothesis seem to hold? Working this problem out, Mallet finds the probability in favour of mere coincidence to be in the ratio of 1 : 1097.81. In summing up, Prof. Clarke, who entered upon his re-calculation with an admitted prejudice against Prout's hypothesis, considers it more probable that the few apparent exceptions are due to constant errors not yet detected than that the great number of close agreements should be purely accidental. To say the very least the hypothesis of Prout cannot be summarily laid aside as refuted. All truly philosophical chemists who wish to lay a secure foundation for their theories cannot fail to set high store upon Prof. Clarke's treatise.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 21, May 22, 1882.

Absorption of Gases by Platinum.—M. Berthelot. —The study of electrolytic polarisation has led the author to investigate the heat disengaged in the absorption of gases by platinum, especially as regards hydrogen and oxygen. He has operated with platinum in various forms, inclosed in small glass globes holding about 75 c.c. fitted with taps, and containing from 50 to 120 grms. of metal. They were placed in a calorimeter, the globes were exhausted, weighed, and the gas was then admitted so as to saturate the platinum at a pressure as near as possible to that of the atmosphere. On weighing again the increase of weight gives the gas absorbed. When this is done the gas is withdrawn by means of the mercurial pump, at first in the cold, and then at 200°, measuring each time the gas, and noting the losses of weight consecutive on its extraction. This is then completed by collecting the gases set at liberty, and heating the metal in a tube of hard glass until the glass begins to melt,—an indispensable counter-proof, without which there is sometimes danger of attributing to a hydride the absorption of oxygen, due in reality to the reduction of a platinous oxide, or to regard as due to some particular state of the platinum an absorption of oxygen, which is in reality due to the oxidation of a hydride. Such hydrides and sub-oxides seem to have been often confounded with platinum itself in the study of the substances called platinum-black. The author finds evidence of two distinct platinum hydrides, the one dissociable and capable of being oxidised in the cold by oxygen, and the other more stable, but capable of being destroyed by the action of heat. All the specimens of platinum-black which the author has been able to procure contained considerable proportions of oxygen, and were sub-oxides. They absorb large proportions of hydrogen, one part of which reduces the oxide, whilst another part forms a hydride. Platinum, in whatever state, if placed in a vacuum and then exposed to oxygen, becomes heated distinctly. The ignition of a

mixture of hydrogen and oxygen by platinum is occasioned by the formation of the less stable hydride and its oxidation in the cold by oxygen.

Action of Oxygenated Water upon Organic Matters and Fermentations.—Paul Bert and P. Regnard.—Oxygenated water in a very dilute state arrests the fermentations due to the development of living beings, and the putrefaction of all substances which do not decompose it. It has no action upon the diastasic ferments. Dilute oxygenated water is destroyed neither by the fats, the amylaceous matters, the soluble ferments, by egg-albumen, caseine, the peptones, creatine, creatinine, nor urea. It is rapidly destroyed by collagenous nitrogenous matters, musciline, blood-fibrine, and various nitrogenous vegetable matters. This action is completely arrested by a temperature higher than 70°, but is not affected by putrefaction.

Measurement of the Carbonic Acid contained in the Atmosphere.—M. Mascart.—The author considers that specimens of 500 c.c. of air are sufficient for the determination of carbonic acid.

Quantity of Carbonic Acid contained in the Air at Calves, near Nyon, at the height of 420 metres.—M. Risler.—The general mean of the monthly determinations from August, 1872, to July, 1873, is 3.035 volumes per 10,000.

Chemical Work produced by the Battery.—D. Tommasi.—Joule and Favre have shown that the power of the galvanic battery is intimately related with the heat produced by the chemical reactions in the battery itself, and that an entire order of questions relative to currents may be treated like problems in calorimetry. Thus the electromotive force of a battery would be proportionate to the heat liberated by the chemical action, and consequently knowing the calories liberated by this chemical action we may find the work which the battery is capable of producing. Favre has shown, however, that the heat brought into play during the combustion of the hydrogen in electrolysis is transmissible or not transmissible to the circuit according to the nature of the compound which furnishes the oxygen necessary for the combustion. Thus, of 131 cal. disengaged by a couple with oxygenated water and hydrochloric acid, there would be merely 41.6 cal. transmissible to the circuit, and representing consequently the energy of the battery. Favre has further observed that in the sulphatation of the zinc of a simple couple (zinc, platinum, and acidulated water), 39 cal. are brought into play, but that of this number only 29.8 cal. are transmissible to the circuit, whilst 9 cal. are confined to the interior of the battery. A zinc-platinum element with dilute sulphuric acid (Smee's) should disengage, according to Favre, 39 cal., but of this number only 29.8 would be transmitted to the circuit, and represent the energy of the battery. Two such elements, therefore, ought not to decompose water. 29.8 cal. + 29.8 cal. < 69 cal. But the author has found that the decomposition takes place as if all the calories disengaged by the two elements had been transmitted to the circuit. 39 cal. + 39 cal. > 69 cal. (Favre), or, calculated according to thermic data, 38 cal. + 38 cal. + 1.4 cal. > 69 cal. If the water of the voltameter is acidulated with hydrochloric acid the decomposition of the water takes place more easily. But even in this case there ought to be no electrolysis, since, according to Favre, 29.8 cal. + 29.8 cal. < 66 cal. If we substitute in the above elements for the two platinum plates two graphites, previously heated to redness—which, according to received ideas, should not in any way modify the chemical action of the battery—the decomposition is produced very briskly. If we employ in the battery electrodes of coke with a large surface, the decomposition of the water is much more energetic. According to Favre two zinc-platinum elements in dilute hydrochloric acid ought not to decompose water if it is acidulated with sulphuric acid, but should decompose it if acidulated with hydrochloric

acid. Two zinc-graphite or zinc-coke elements decompose water acidulated with sulphuric acid. This decomposition cannot be explained according to Favre, but it is intelligible according to thermic data: 34.2 cal. + 34.2 cal. + 1 cal. > 69 cal. A zinc-platinum element in dilute hydrobromic acid ought, according to Favre, to liberate 35.9 cal., but only 29.9 cal. would be transmitted to the circuit. Two of these elements, therefore, ought not to decompose water acidified either with sulphuric or hydrochloric acid, for in the former case 29.9 cal. + 29.9 cal. < 69 cal., and in the second 29.9 cal. + 29.9 cal. < 66 cal. If the water of the voltameter is acidulated with sulphuric acid, decomposition sets in, but ceases soon. The decomposition of the water is more marked with two zinc-coke elements. If the water of the voltameter is acidulated with hydrochloric acid, the decomposition takes place more easily. If the water of the voltameter is acidified with hydrobromic acid, there is also electrolysis, but in this case it is not the water which is decomposed, but the hydrobromic acid itself. However this acid is diluted, gas always escapes at the negative electrode, but at the positive electrode there is no escape of gas, but there appears around the platinum wire a yellow thread of bromine. This fact is easily explained, since 2 mols. hydrobromic acid absorb 59 cal. for decomposition, whilst 1 mol. water absorbs 69 cal., and, as the author has shown in 1879, the compound which absorbs the least calories is always decomposed in preference by the current.

Use of Revolving Discs for the Study of Colour-Sensations. Relative Intensity of Colours.—A. Rosenstiehl.—This paper requires the accompanying diagram.

Hydrosulphate of Nickel Sulphide.—H. Baubigny.—See p. 249.

Action of Alkaline Sulphides upon Stannous Sulphide.—A. Ditte.—If potassium mono-sulphide is caused to act upon stannous sulphide with access of air, the alkaline liquid, even if dilute, dissolves a little of the metallic sulphide, but by the action of the oxygen, which transforms it into a bisulphide soluble in the potassium sulphide, there is produced at the same time a little potassa. The reaction continues thus very slowly, as the liquid obtains oxygen from the atmosphere. If the primitive liquid is sufficiently concentrated, the metallic proto-sulphide is decomposed with formation of sulpho-stannate and of metallic tin; as for the potassa formed under the influence of the air, it is too small in quantity to act in presence of the excess of potassium sulphide.

Researches on the Cuproso-cupric Sulphides.—A. Etard.—The author describes a yellow salt, which might be named an octo-sulphite of cuprosium, cupricum, and sodium, and which if treated with sulphurous acid passes into Chevreul's salt, $\text{SO}_3\text{Cu}_2\text{SO}_3\text{Cu}_2\cdot 2\text{H}_2\text{O}$. The yellow salt is prepared by shaking up anhydrous copper sulphate, pulverised in an open flask with a solution of sodium bisulphite at sp. gr. 1.26. If the yellow salt is treated in the cold and with contact of air with sodium bisulphite, there is formed a deep reddish brown salt in spherical agglomerations, $\text{S}_8\text{O}_{23}\text{Cu}_4\text{Na}_8 + 9\text{H}_2\text{O}$.

Basic Salts of Manganous Oxide.—A. Gorgeu.—A description of a sub-sulphate, sub-nitrate, and oxy-chloride.

Addition of Hypochlorous Acid to Mono-chlorated Allyl-chloride.—L. Henry.—The reaction gives rise to two distinct products: symmetric bichlorated acetone and allene-tetra-chloride.

Bulletin de la Société Chimique de Paris,
Tome 37, No. 8, 1882.

Oxidation-Products of Charcoal obtained by Electrolysis.—A. Millot.—The author refers to the researches of MM. Bartoli and Papasogli (*Comptes Rendus*, No. 20, 1882), and to similar investigations of his own (vol. xxxiii., p. 262).

Electrolytic Determination of Zinc in Ores.—A. Millot.—Various procedures have been suggested for the electrolytic determination of zinc. An acetic solution has been employed, or by preference a sulphuric, with the addition of ammonium sulphate. The deposit obtained is very adhesive, but the last traces of copper are very hard to separate. M. Beilstein recommends for the determination of zinc in brass, after separating the copper in a nitric solution, the precipitation of the solution by potassa, and the re-dissolution of the precipitate by potassium cyanide. This method occasions the platinum of the electrodes to be attacked, and the formation of a black deposit of finely-divided platinum upon the negative pole. The author has previously proposed the use in this determination of an excess of caustic potash, which gives a very adhesive deposit of zinc, similar to that obtained with cyanide. With pure potassa, entirely free from chlorides, the platinum electrodes are not attacked. The following process gives the best result with ores of zinc: Dissolve 2.5 grms. of the ore in 50 c.c. hydrochloric acid, adding whilst boiling a little potassium chlorate to precipitate the iron. If much silica is present the solution is evaporated to dryness with a little hydrochloric acid. The liquid, when cold and diluted, is mixed with 100 c.c. of ammonia and 5 c.c. of a saturated solution of ammonium carbonate to precipitate the lead and the lime. When cold it is diluted to a half litre and filtered. We take 100 c.c. of the filtrate, corresponding to $\frac{1}{3}$ gm. of the ore, and containing from 0.2 to 0.3 gm. of zinc. There is added 1 gm. pure potassium cyanide, and the whole is placed in a precipitating glass. As a positive pole a cylinder of platinum wire gauze is used, and for a negative pole we place in the interior of the cylinder a platinum cone of the apparatus of M. Riche. The distance between the cone and the gauze ought to be a few millimetres. A current is passed through the solution answering to two Bunsen elements, or that of a Clamond's thermo-electric pile of 150 elements. If the liquid contains 0.25 gm. of zinc there are precipitated in the first hour 0.15 gm.; in the second hour 0.075 gm. The last portions of the metal are more difficult to separate, but in nine or ten hours the precipitation is complete. The deposit is very adhesive; it is washed in alcohol, then in water, and the cone is dried and weighed. The zinc is then dissolved off in hydrochloric acid, and the cone is dried and weighed anew. If the ore contains copper, it is deposited with the zinc. The deposit is re-dissolved in nitric acid, and the copper is precipitated by electrolysis in an acid liquid. Cadmium alone is determined along with the zinc, which is the case also in volumetric determinations. When it is present in the ore in notable proportions it must be removed by means of sulphuretted hydrogen. The quantity of potassium cyanide must be exactly limited. If more is used than the weight given the metal will be deposited more slowly, and if the quantity is less the deposit is not adherent. This electrolysis in alkaline liquids occasions an attack of the platinum electrodes, and the formation at the negative pole of a black coating of finely-divided platinum, which is not removed by treatment with acids, but which changes continually the weight of the cone. The author avoids this inconvenience, due to the decomposition of ammonium hydrochlorate and the formation of nascent chlorine, by adding to the liquid to be electrolysed 5 c.c. of a saturated solution of ammonium acetate. The acetate is decomposed by the current, and no chlorine is formed, so that the electrodes are not attacked. Ammonium nitrate answers the same purpose, but it delays the precipitation of the zinc. The results obtained in the absence of cadmium are absolutely exact.

Russian Chemical Society.—Session April 2/14, 1882. —M. Teploff continues his studies on the structure of molecules.

M. Beilstein and Kourbatoff presented their results be composition of the crude petroleum distilled in works of Siemens and Halske. It consists chiefly of

saturated hydrocarbons, but it contains also a small quantity of aromatic hydrocarbons.

M. Lubavine pointed out a method of preparing glyoxal by the action of nitric acid upon aldehyd.

M. Werigo called to mind that as far back as 1879, experiments on the oxidation of glycerin were being conducted in the laboratory of the University of Odessa.

M. Przybytek completed his communication (referred to by M. Werigo) on the products of the oxidation of glycerin by means of nitric acid at common temperatures.

M. Wilm, in pursuing his researches on the platinum metals, arrived at the following conclusions: The metals of this group, and especially palladium and rhodium, when they have been precipitated by iron, zinc, hydrogen, or sodium formate, dissolve with remarkable ease in hydrochloric acid in presence of air. Pure rhodium absorbs hydrogen with much greater energy than palladium. The platinum metals cannot be separated from the base metals, such as copper or lead, by means of reducing agents, as they carry down a certain quantity of these metals.

M. Stcherbakoff sent in a paper on the action of normal butyryl chloride upon normal zinc propyl. M. Stcherbakoff also gave a communication on the preparation and properties of zinc propyl.

A memoir was read from MM. Markownikoff and Kabloukoff on a hexylic glycerin, and one from M. Markownikoff on the molecular transformation of tin.

Revue des Industries et des Sciences Chimiques et Agricoles.
No. 53, 1882.

Determination of Salicylic Acid in Alimentary Substances.—MM. Pellet and De Grobert.—A voluminous memoir, in which the authors describe the determination of salicylic acid in butter, milk, and urine. The process is volumetric, and the authors make use of a colorimetric of ferric chloride at 1.005 to 1.008 sp. gr., containing 0.5 gm. acid in 100 c.c. They take 25 grms. butter, place it in a cylinder graduated at 200 c.c., add 5 or 6 drops of sulphuric acid at 30° B., and a certain volume of benzol, e.g., 75 c.c., and shake strongly. All the fatty substance is dissolved, and a whitish matter remains in suspension. The total volume is noted, and is made up to exactly 100, 110, or 120 c.c. The solution is filtered; 5 or 10 c.c. of it are taken, and placed in a test-tube of the same diameter as the tubes of the colorimeter; 5 or 10 c.c. of water are added, and 2 or 3 drops of the ferric chloride above mentioned. The tube is shaken repeatedly, but gently, to prevent an emulsion, and when the tint of the lower liquid no longer deepens, it is compared with a standard tube. For greater exactitude the comparison is made not with a tube containing merely water, but with a tube in which is a solution of benzol having dissolved 25 grms. of butter free from salicylic acid per 100 c.c. We place 10 c.c. of this normal solution of butter free from salicylic acid in a test-tube; then 0.2 c.c. or 0.1 c.c. of a solution of salicylic acid at 1 gm. per litre, and 9.8 c.c. or 9.9 c.c. of distilled water; then, lastly, 2 drops of the ferric chloride, and agitate. The proportion of salicylic acid is judged by the comparative colour.

Manufacture of Borax from Boracic Acid.—M. Donnay.—An account of the production of borax from the lagoons of Castel, Nuovo, Tuscany.

Disinfection of Alcohols by Electrolysis.—MM. Naudin and Schneider.—Already noticed.

No. 54, 1882.

Disinfection and Agricultural Utilisation of Blood.—P. Marguerite-Delacharlonny.—The author gives the proportion of nitrogen in dried blood as 12.15 to 18.73 per cent, and the phosphoric acid at 1.63 to 2 per cent. The value of the blood of the 43 million animals yearly slaughtered in France he estimates at 21 million francs. The author describes various methods proposed for

treating blood so as to prevent nuisance. A mixture recommended for this purpose by the Conseil d'Hygiène de la Seine is as follows:—

Sodium sulphate	.. .. .	0.60 kilos.
Crude phenol	.. .. .	0.15 "
Common vinegar	.. .. .	0.15 "
Sulphuric acid	.. .. .	0.025 "
Water	.. .. .	2.500 "

This quantity is to serve for 100 litres of blood.

Note on Apparatus employed in Determining the Dry Extract furnished by Various Industrial Products.—Armand Le Docte.—This paper cannot be intelligibly reproduced without the two accompanying figures.

Disinfection of Alcohols by Electrolysis.—MM. Naudin and Schneider.—Continued from the last number.

Purification of Waste-Waters from Manufactories.—MM. Gaillet and Hunt.—In this preliminary paper the authors decide that irrigation must in the majority of cases be rejected. Where it is not impracticable it is dangerous.

Cosmos Les Mondes.

No. 3, May 20, 1882.

Mutual Attraction of Ores.—Prof. Doelter.—The author, when experimenting upon various ores with electro-magnets, remarks that the quantity of iron present does not determine the degree of attraction of ores. The sulphides and sulphates which contain much iron are little attracted, whilst the attraction of the oxides, carbonates, and silicates, is very strong. This variation in the quantity of attraction may be useful in the mechanical separation of natural mixtures of ores.

MEETINGS FOR THE WEEK.

WEDNESDAY, 21st.—Meteorological, 7.

Geological, 8.

THURSDAY, 22nd.—Royal Society Club, 6.30. (Anniversary).

FRIDAY, 23rd.—Quekett Microscopical Club, 8.

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THE CHEMICAL NEWS.

VOL. XLV. No. 1178.

NOTE ON β -NAPHTHAQUINONE.*

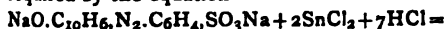
By CHARLES E. GROVES.

IN a paper by Liebermann, published last year in the *Berichte* (xiv., 1310), as also in a more recent communication to the *Annalen* (ccxi., 51), he recommends β -naphthol orange as the most convenient source from which to prepare β -naphthaquinone. Knowing the ease with which β -naphthol can be converted into amido- β -naphthol, this statement seemed to me so extraordinary that I was induced to investigate the reaction.

Liebermann recommends that β -naphthol orange, the sodium salt of β -naphthol-diazo-benzene sulphonic acid, $C_{10}H_6(OH).N_2.C_6H_4.SO_3Na$, should be treated with stannous chloride and hydrochloric acid in quantity sufficient to produce the double tin salt of amido- β -naphthol hydrochloride. This occurs in the product mixed with sulphanilic acid from which the amido- β -naphthol is separated by treatment with hydrogen sulphide to remove the tin, then decomposing with sodium carbonate, and agitating with ether, of which large quantities are required, as the base is but sparingly soluble in it. On mixing the solution of the sulphate of the base with an oxidising chromic mixture in the manner described by Stenhouse and myself, the β -naphthaquinone is precipitated.

I carefully repeated these experiments of Liebermann, and can fully corroborate his statements as to the results, but not as to the value of the process as a method for preparing β -naphthaquinone. The decomposition of the tin double salt by hydrogen sulphide, involving as it does the precipitation of such a large amount of tin, and the extraction with ether are troublesome and tedious, and the unavoidable loss of ether is considerable. If, on the other hand, we attempt to prepare the β -naphthaquinone from the solution without first separating the sulphanilic acid (whether the tin be precipitated by hydrogen sulphide or by metallic zinc), the product is not satisfactory either in quantity or quality.

It was evident that, in order to render the process practicable, the treatment with hydrogen sulphide must be avoided, and a more convenient method of separating the amido- β -naphthol from the sulphanilic acid must be devised. A few preliminary experiments showed that these difficulties could be easily overcome. If, instead of employing the large quantity of stannous chloride recommended by Liebermann, but little more is taken than that required by the equation—



$HO.C_{10}H_6.NH_2Cl + NH_2.C_6H_4.SO_3H + 2NaCl + 2SnCl_4$, the azo-compound is completely decomposed, and the amido- β -naphthol crystallises out not as double tin salt, but as hydrochloride mixed of course with sulphanilic acid: the necessity for removing large quantities of tin as sulphide is thus avoided. After separating the mother-liquors containing the stannic chloride, and washing with a little cold water, dilute soda solution is added to the crystalline mass until it is in slight excess over that required to combine with the sulphanilic acid and with the hydrochloric acid of the amido- β -naphthol hydrochloride; this may be known by the mixture rapidly becoming brown on the surface exposed to the air: a little hydrogen sodium carbonate is then added sufficient to neutralise the excess of sodium hydroxide. In this way

free amido- β -naphthol is obtained suspended in a solution of sodium chloride and sodium sulphanilate. As the base is almost insoluble in water and in sodium carbonate solution, it can be collected on a vacuum filter, washed with water, and converted into the hydrochloride by hydrochloric acid. The yield of crystallised amido- β -naphthol hydrochloride is from 34 to 38 per cent of the weight of the β -orange. This agrees almost exactly with the result obtained by Liebermann with the double tin salt by means of hydrogen sulphide and ether (30 per cent base or 38.3 per cent hydrochloride). One of the sources of loss in the preparation of amido- β -naphthol in this way appears to be the regeneration of naphthol; at least I have always found β -naphthol in the product usually to the amount of 4 to 5 per cent.

Even when thus simplified, however, the process just described is more troublesome, and takes more time than the conversion of β -naphthol into the amido-naphthol through the nitroso-compound, the details of which I have slightly modified. The nitroso- β -naphthol, which is easily prepared from β -naphthol by treatment with nitrosyl sulphate, or sodium nitrite and an acid, is dissolved in dilute soda, filtered, and precipitated by a strong solution of soda. The green sodium compound, after being washed once or twice with dilute soda, is at once treated with hydrogen sulphide, which quickly reduces it to amido- β -naphthol. This is collected, washed with hydrogen sulphide solution, and converted into the hydrochloride, the yield being 73 to 75 per cent of the weight of the β -naphthol originally taken.

Now, as the commercial value of β -naphthol is not more than half that of β -naphthol orange, and since it yields twice as much amido-naphthol, it follows that to produce a given quantity of β -naphthaquinone, the cost of original material will be four times as great if Liebermann's process be employed as with that originally proposed by Stenhouse and myself, but what is even of more importance in research, his process is the more troublesome and tedious.

It has also been suggested that α -naphthol orange is a good source for the preparation of α -naphthaquinone. It has not, however, even the advantage of being a commercial product; moreover, the α -orange seems to be a mixture of two isomeric azo-compounds; at least, on reducing it with stannous chloride and hydrochloric acid, two amido-naphthol hydrochlorides are produced, one of which—the least soluble—does not yield α -naphthaquinone when treated with oxidising agents, and appears to be identical with the amido- α -naphthol obtained by the action of reducing agents on yellow nitroso-naphthol.

I have also employed hydrogen sulphide in presence of excess of soda or ammonia as a reducing agent for naphthol orange. With the α -orange the results were unsatisfactory. With the β -orange the yield of amido- β -naphthol hydrochloride was sensibly the same as that obtained by Liebermann's method, and affords a ready method of preparing small quantities of amido- β -naphthol.

Preparation of β -Naphthaquinone.—In preparing either α - or β -naphthaquinone from the corresponding amido-compounds, I have discontinued the use of chromic mixture, and employ ferric chloride instead, as the oxidising agent. It has the advantage in the case of β -naphthaquinone, that, even if used in excess and allowed to stand some time in contact with the precipitate, the quinone does not undergo any change, whilst with the more energetic chromic mixture it is attacked, and brown amorphous products are formed.

I hope in a future communication to describe some of the products obtained from β -naphthaquinone and from the amido-naphthols.

Mr. MELDOLA stated that soon after the publication of Liebermann's note he had tried the process and experienced the difficulties mentioned by Mr. Groves, but by using ammonium sulphide instead of stannous chloride he had obtained good results.

* Read before the Chemical Society, June 15, 1882. Communicated by the Author.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.*

By J. W. MALLET, F.R.S.,

Professor of Chemistry in the University of Virginia.

(Continued from p. 257.)

6. *Experiments of Dumas*, 1858.—Dumas+ re-determined the atomic weight in question by dissolving in water known weights of aluminum chloride, and ascertaining the quantity of silver, used as nitrate, which was required in each case for precipitation of the chlorine. The aluminum chloride had been carefully prepared on the large scale, then sublimed from iron turnings, and re-sublimed from aluminic filings. It sometimes still contained traces of iron. Each specimen to be used was sublimed for the last time from aluminum, in a stream of dry hydrogen, into a small glass tube, which was sealed at both ends before the lamp, and reserved for one of the analytical experiments. Of these there were seven. In each the weight of the sealed tube and its contents was taken, a drawn out end opened, and the weight quickly verified after equilibrium of pressure with the outside air had been thus established; the tube was introduced into water, and after solution of its contents the weight of the empty tube was determined. It does not appear from the published paper how the risk of mechanical loss from violent action of the chloride on the water was guarded against; from my own experiments with the bromide this appears to be a point requiring careful attention. Nor is it stated how the quantity of silver used was determined, whether by weighing the chloride of silver formed, by measuring the volume of a standard solution of silver nitrate, or by weighing off a little less metallic silver than would be required, converting this into nitrate, adding it to the aluminum chloride solution, and completing the precipitation with a measured quantity of dilute standard solution of silver nitrate. Nor is it mentioned how, if at all, the error due to slight solubility of silver chloride in the liquid from which it was precipitated is obviated—a point not ignored by Dumas, as appears from another part of the same paper,; and afterwards very carefully examined by Stas.

The results of the seven experiments were as follows, the atomic weight or equivalent being calculated for the formula Al_2Cl_3 , and on the supposition that $\text{Ag} = 108$, and $\text{Cl} = 35.5$:—

				Atomic Weight,
I.—1'8786	of Al_2Cl_3	required	4'543	of $\text{Ag} = 13'74$
II.—3'021*	"	"	7'292	" = 13'85
				(should be 13'86)
III.—2'399	"	"	5'802	of $\text{Ag} = 13'73$
IV.—1'922	"	"	4'6525	" = 13'68
V.—1'697	"	"	4'1015	" = 13'77
VI.—4'3165	"	"	10'448	" = 13'68
VII.—6'728	"	"	16'265	" = 13'76
Mean	..	..	..	.. 13'744
Should be	..	..	..	.. 13'746
				or 27'492 for AlCl_3

* Contained traces of iron.

Re-calculating this table for the formula AlCl_3 , and using the atomic weights of Stas for silver (107.66) and chlorine (35.37), the figures of the last column become—

I.—Atomic weight of Al	.. ..	= 27.447
II.—" "	.. ..	= 27.666
III.—" "	.. ..	= 27.435
IV.—" "	.. ..	= 27.318
V.—" "	.. ..	= 27.522
VI.—" "	.. ..	= 27.327
VII.—" "	.. ..	= 27.489
Mean	.. ..	27.462

* From the *Philosophical Transactions* of 1880. Paper read before the Royal Society, April 22, 1880.

† *Annales de Chimie et de Physique* (3), 55 (1859), 151.
‡ Page 135.

It is to be remarked that the tendency of the chief causes of error connected with these experiments is in the same general direction. The presence of any iron in the chloride used; the action upon it, though but to a minute extent, of any trace of moisture in the hydrogen in which it was finally sublimed; any loss occurring with the fumes formed on introduction of the chloride into water; and the retention of traces of silver chloride in solution in the liquid from which the main mass of this compound had been thrown down; any or all of these would tend to diminish the quantity of silver chloride obtained, and therefore to make the atomic weight of aluminum appear greater than it really is. In discussing results which we owe to the labours of such experimenters as Berzelius and Dumas, it is of course to sources of error likely to inhere in the method itself that attention should especially be given.

Dumas also tried dissolving aluminum (containing iron and silicon in considerable quantity) in hydrochloric acid, adding nitric acid in excess, evaporating to dryness, igniting and weighing the alumina (and other oxides) left behind. From an analysis of the crude metal employed, so as to allow for the impurities present, and on the basis of three experiments made as above, he calculated the atomic weight as

$$\begin{array}{l} 13.74 \text{ (} = 27.48 \text{ for Al}_2\text{O}_3\text{—O} = 16) \\ 13.87 \text{ (} = 27.74 \text{ " " — ")} \\ 13.89 \text{ (} = 27.78 \text{ " " — ")} \end{array}$$

but he was dissatisfied with these results, having found that the impurities of the metallic aluminum were unequally distributed throughout its mass, and having been unable to obtain the metal in a pure state. He considered the results furnished by the experiments with the chloride as accurate, and concluded that the atomic weight of Al is represented by the number 13.75 (for Al_2Cl_3)—this becomes 27.5 for AlCl_3 or Al_2Cl_6 .

7. *Experiments of Tissier, 1858.*—Ch. Tissier* prepared aluminum by reducing very pure fluoride of aluminum and sodium—probably cryolite, although this is not stated—by means of purified sodium in a carbon crucible, re-fusing the metal several times in order to free it from any of the flux which might have been retained. No account is given of the means taken to prepare a carbon crucible free from iron and silicon; and to prevent destruction of the crucible by its material burning away during the fusion at high temperature of the aluminum salt with sodium. The metal was tested for iron by dissolving it in nitro-hydrochloric acid, evaporating to dryness with a large excess of nitric acid, and igniting the residue of alumina, which was observed to be of brilliant whiteness, while the addition of a solution containing a few thousandths of iron sufficed "to colour it very strongly red." Why the much more delicate tests available for iron in the original solution were not used does not appear.

As regards silicon, it is stated that "the solution of the metal by means of hydrochloric acid left no trace of silicon;" no mention is made of the solution having been evaporated to dryness, the residue re-moistened with strong hydrochloric acid and dissolved in water in order to see whether silica was left. A portion of the solution obtained with nitro-hydrochloric acid was evaporated to dryness, the residue ignited, and the alumina so left was digested with a strong and boiling solution of ammonium nitrate. This solution was evaporated to dryness, and left a residue of sodium nitrate representing 0.135 per cent of sodium in the metallic aluminum.

1.935 grm. of this aluminum was dissolved in hydrochloric acid, the solution evaporated with an excess of nitric acid until all chlorine was completely driven off, and the residue heated until the nitric acid was also completely removed and alumina only was left. This alumina weighed 3.645 grms. In the paper recording this single experiment the resulting atomic weight is not calculated, but the author simply points out that the number 14, which

* *Comptes Rendus*, 46 (1858), 1105.

he says many chemists adopt as representing aluminum, must be too high, while 13.75, the number assigned by Dumas, is in all probability accurate. In support of this view it is calculated that, if $Al = 14$, the alumina obtained in the above described experiment should have weighed 3.590 grms; whereas, with $Al = 13.75$, its weight should have been 3.624 grms. In getting these figures 0 is taken = 8.

But, if the minute quantity of sodium stated to have existed in the metal used be deducted, and allowed for as sodium oxide (aluminate) in the last weighed residue, and if the results obtained be calculated, for alumina = Al_2O_3 , with Stas's number for oxygen (15.96), the atomic weight of aluminum will be represented by 27.068, a number much nearer to 27 than to 27.5 (13.75×2), the value assumed as most probably correct by Tissier.†

8. *Experiments of Terrell*, 1879.—Lastly, about a year ago Terrell‡ made a determination of the constant in question by passing hydrochloric acid gas over metallic aluminum, collecting and measuring the hydrogen evolved. He placed a known weight of aluminum in a tube of hard glass, the tube wrapped with foil so as to allow of its being made red-hot. By one end a stream of well dried gaseous hydrochloric acid could be introduced, while a smaller tube extended from the other end and dipped into a vessel of water.

The air was first expelled from the apparatus by a current of dry carbon dioxide, and not until the gas passing through was capable of being completely absorbed by a solution of potash was the hydrochloric acid introduced, this latter itself freed from atmospheric air. The gas escaping from the tube was now collected in a graduated jar, and the temperature of the tube containing the aluminum was raised to a red heat. As soon as hydrogen ceased to come over, the gas in the jar was shaken up with potash to absorb any carbon dioxide which it might contain, and the volume was measured, and reduced by calculation to its equivalent under normal temperature and pressure. The aluminum chloride left in the tube was pulverulent and snow white.

No details are given of the method by which pure metallic aluminum was prepared, although this has been the great difficulty in the way of obtaining accurate results from experiments made with the metal as the starting point, nor is there any record of the tests applied to prove the purity of the metal used. The gas was collected over water, in which hydrogen is not altogether insoluble, and from which more or less of the gases of atmospheric air would be given off into the hydrogen. Nothing is said of the vapour of water, mixed with the hydrogen in proportion depending upon the temperature, having been removed, or its amount calculated and allowed for; though as it is not likely that so obvious a precaution was neglected, it may be supposed that the potash spoken of as used to absorb any carbon dioxide left was either solid hydrate or so strong a solution as to have also removed most if not all the aqueous vapour.

The results of the single experiment reported were—

Weight of aluminum 0.410 grm.
Volume of hydrogen collected at
11° and 768 mm. 530 c.c.
Corresponding volume at normal
temperature and pressure .. 508.2 c.c.
Weight of this hydrogen 0.0455 grm.

from which the author calculates

$$0.0455 : 0.4100 = 1 : 9.01,$$

* This ought to read 3.594.

† Since this paper was printed in the *Philosophical Transactions* my attention has been drawn by Prof. W. F. Clarke, of Cincinnati, to a single other determination made in 1868 by Ienard (*Comptes Rendus*, 66, 506). The report of this is very brief and without any satisfactory details, the whole of it being the following lines: "The process employed by the author consists in attacking the metal by hydrochloric acid. He finds that 9 grms. of aluminum, attacked by pure hydrochloric acid, invariably give, after calcination, 17 grms. of alumina; whence he concludes that 9 would represent the equivalent of aluminum as referred to hydrogen taken as unity."

‡ *Bulletin de la Société Chimique de Paris*, 31, (Fév. 20, 1879), 153.

giving the atomic weight 13.515 (for Al_2Cl_3) or 27.03 (for $AlCl_3$).

In verifying the above calculation I have found as the result of reducing the volume of hydrogen from the given to normal temperature and pressure 514.85 c.c. instead of 508.2 c.c., but this, I am satisfied, arises from the number representing the pressure at the time of experiment being, doubtless by a printer's error, wrongly given as 7.68 instead of 7.58 m.m. With the latter figures the result is as recorded in the paper, and of course such atmospheric pressure is more frequently observed than that which appears in the above table.

It is pretty plain that from the researches which have been quoted we may reject those of Davy, Thomson, and Mather as incapable of giving exact results, this being either admitted by the authors themselves or shown by an examination of their methods and the inconsistency of their conclusions. Our knowledge of the atomic weight under consideration rests therefore upon the investigations of Berzelius, Tissier, and Terrell, each of whom made one experiment, and those of Dumas, who made seven.

General Results of Former Determinations.—If all the results be taken as I have re-calculated them, using Stas's atomic weights for the other elements concerned, and equal value be given to all, we shall have the following arithmetic mean—

Berzelius	..	..	..	27.237
Dumas	..	..	..	27.447
"	..	..	..	27.696
"	..	..	..	27.435
"	..	..	..	27.318
"	..	..	..	27.522
"	..	..	..	27.327
"	..	..	..	27.489
Tissier	..	..	..	27.068
Terrell	..	..	..	27.030
Mean	..	..	..	27.357

If, however, the results of Dumas, all depending on repetition of the same process, be viewed as possibly affected by some constant error, and be thrown together, taking into the calculation the mean only of his seven experiments, the general mean will be—

Berzelius	..	..	..	27.237
Dumas (mean)	..	..	..	27.462
Tissier	..	..	..	27.068
Terrell	..	..	..	27.030
Mean	..	..	..	27.199

If we separate Dumas's results, and take the mean of the other three, we get in contrast—

Berzelius	..	..	..	27.237
Tissier	..	..	..	27.068
Terrell	..	..	..	27.030
Mean	..	..	..	27.112
Dumas (mean)	..	..	..	27.462

Or, if we throw together only the numbers obtained by Tissier and Terrell, which come nearest to each other, we have—

Tissier	..	..	..	27.068
Terrell	..	..	..	27.030
Mean	..	..	..	27.049
Berzelius	..	..	..	27.237
Dumas (mean)	..	..	..	27.462

Values now generally adopted for Atomic Weight of Aluminum.

The number adopted in some of the more recent chemical handbooks, reports, &c., may be quoted as follow*

GMELIN: Handbook of Chemistry (Cav. Soc. Trans.)	274
WATTS: Dictionary of Chemistry, First Supplement	274
W. A. MILLER: Elements of Chemistry, 4th edit.	275
MEYMOOT TIDY: Handbook of Modern Chemistry	275
FRANKLAND: Lecture Notes for Chemical Students	275
THORPE: Quantitative Chemical Analysis	275
Agenda du Chimiste (WURTE's Laboratory, 1879)	275
Annuaire du Bureau des Longitudes, 1876	274
NAQUET: Principes de Chemie, &c., 3e ed.	275
FITTTA: Jahresb. üb. d. Fortsch. d. Chemie, 1878	274
ROSCOE u. SCHORLEMMER: Ausf. Lehrbuch d. Chemie (Ger. ed.)	273
FRESENIUS: Anleit. z. quant. chem. Analyse, 5te Aufl.	275
CLASSEN: Grundr. d. anal. Chemie (quant.)	273
KOHLRAUSCH: Leitfaden de Prakt. Physik, 2te Aufl.	274
MENDELEJEFF: Paper on the "Periodic Law" (transl.)	273
J. P. COOKE, Jr.: The New Chemistry	275
J. D. DANA: System of Mineralogy, 5th ed.	275
E. S. DANA: Text-Book of Mineralogy	273

New Experiments by the Author.

During the last three years I have devoted a large part of my leisure time to a re-determination of this atomic weight, sparing no pains to attain as precise a result as possible, and aiming especially at the discovery, and as far as possible the removal, of sources of error connected with the methods employed. The following general principles have been kept in view:—

1. That each process used should be as simple as possible, and should involve as little as possible of known liability to error.
2. That different and independent processes should be resorted to as the means of checking each other's results, even though it may fairly be assumed that one is more advantageous than another.
3. That each process should be carried out with quantities of material differing considerably from each other in successive experiments.
4. That only such other atomic weights should be involved as may be counted among those already known with the nearest approach to accuracy.

The most scrupulous care was taken in the purification and examination of all the reagents used, and as far as possible vessels of platinum or of hard porcelain were substituted for those of glass.

Means and Method of Weighing Employed.—For the weighings an excellent balance, of Becker's construction, was employed. It was in perfect order, carefully adjusted (especially as regards centre of gravity of beam with average load to be carried), and would bear safely 200 grms. in each pan, giving when thus loaded a deflection of the index to the extent of $1\frac{1}{2}$ division of the scale over which it moves for a difference of weight of 0.0001 grm. All weighings were made by the well-known method of observing the vibrations of the index on either side the position of rest. In one series of experiments *absolute* weights were required, i.e., real equality of weight between the quantities of matter dealt with and the standards of weight with which they were compared; in these cases the method of "double weighing" was made use of, so as to eliminate any error arising from inequality in length of the arms of the balance. In view of this need, in connection with a part of the research, for absolute weights, directly comparable with those used by Regnault in his determination of the density of hydrogen, I applied to my friend J. E. Hilgard, Esq., in charge of the office of the United States' Coast Survey at Washington, for a comparison of a kilogramme with a weight of the same denomination belonging to the Coast Survey, the value of which latter weight is accurately known in terms of the original "kilogramme of the Archives" at Paris. He kindly had this comparison made, and sent me the results in detail, showing that my weight was 8.1 milligrammes

heavier than the "star kilogramme" which is the standard of reference at Washington (both *in vacuo*), with an uncertainty of comparison not exceeding 0.1 milligramme, while the "star kilogramme" is certified to as agreeing with the normal "kilogramme of the Archives" within 1.1 milligramme. I had already a 10-gramme weight, professedly normal, but, as it turned out, too light by a very minute fraction of its value, and with these two, checked against each other, a full series of comparisons was made of all the other weights to be employed, the specific gravity of each piece being determined before its final comparison as to weight, so that the real values might all be referred to a vacuum by calculation of the buoyancy in air. Determinations of the specific gravity of all materials and vessels which had to be made were also made, and, the barometer and thermometer being observed at the time of each weighing, all weights hereafter mentioned in this paper represent real values *in vacuo*.

Three separate series of experiments were made, by methods to be presently stated. A fourth series was attempted, involving the conversion of metallic aluminum into oxide and determination of the amount of oxygen taken up, but this process was found to be attended with much difficulty from various causes, amongst others from the liability to loss by spitting if the metal were treated with acid in open or small vessels, from the necessity of transfer to such vessels for final ignition if larger ones were at first used, and from the appreciable solubility of the hydrate of aluminum if this were precipitated in order to avoid evaporation of the original solution. The few results obtained in this way agreed generally with those of the other methods, but varied among themselves within unsatisfactorily wide limits, and were manifestly not deserving of equal confidence. Hence the work was not pushed further in this direction.

(To be continued.)

ON THE SOLUBILITY OF SULPHUR DIOXIDE IN SULPHURIC ACID.*

By J. T. DUNN, M.Sc.

HAVING determined the solubility of sulphur dioxide in concentrated sulphuric acid at the ordinary temperature, as stated in my note of last January (*Transactions*, vol. v., p. 39), I thought it would be desirable to extend the determinations to other temperatures and to other strengths of acid. I first set about determining the solubility in concentrated acid at different temperatures, and since for obvious reasons, the method of direct weighing would be inapplicable, it was necessary to use some method in which a known quantity of the saturated acid could be withdrawn at the temperature of the experiment and its content of SO₂ determined.

I consequently made use of the apparatus described by Bunsen in his "Gasometry," with a very slight modification. A large test-tube was fitted with a cork pierced by three holes: through the first a thermometer was inserted; through the second passed the tube from the SO₂ supply down to the bottom of the test-tube; and through the third passed a glass tube bent twice at right angles, which served as exit tube for the superfluous gas while the saturation was going on, and which, by simply pushing it down through the cork until it dipped beneath the acid, was converted into a delivery tube for the saturated acid.

In this apparatus was placed about 50 c.c. of the acid to be saturated, and the whole was then placed in a large beaker of water, which could be kept at any temperature by the help of a Bunsen burner and an electric thermostat. The temperature indicated by the thermometer in the acid

*A Paper read before the Newcastle-upon-Tyne Chemical Society, March 23, 1882.

never varied more than half a degree during the whole time of an experiment. Through the acid in the apparatus was now passed a moderately rapid current of SO_2 , prepared from copper and pure sulphuric acid, and carefully dried, for lengths of time sufficiently great to insure the complete saturation of the acid. The exit-tube was now pushed down into the acid (and beneath the level of the SO_2 delivery tube, so as to avoid accidental entrance of bubbles into it), and of course the pressure of the SO_2 still entering the vessel forced the liquid out through the tube. It was permitted to flow into a small stoppered bottle, the capacity and weight of which were known; the delivery tube went to the bottom of the bottle, and the acid gradually and quietly displaced the air. When the bottle was full and had overflowed for some time, the delivery tube was slowly withdrawn and the stopper immediately inserted. In this way a known volume of the saturated acid was obtained, without any escape of SO_2 , and it had now to be weighed and the SO_2 determined by chemical means.

I intended at first to use Bunsen's method of titration by iodine and hyposulphite, but the trouble of preparing the large bulks of air-free distilled water necessary to dilute the acid induced me to seek for another method. I tried at first direct titration with permanganate, but I soon found that unless very large bulks of fluid were used the escape of SO_2 from the liquid during titration was a serious source of error. I then tried sinking the acid under excess of permanganate, and titration with excess of ferrous sulphate and permanganate, but finally settled down to bichromate. The bottle containing the weighed quantity of saturated acid was opened under a known quantity of standard bichrome solution, time was allowed for the complete diffusion of the acid out of its bottle, and then the unaltered bichrome was determined by adding excess of standard ferrous sulphate and titrating back with bichrome.

The weight of SO_2 determined in this way was calculated into its volume at normal pressure and temperature. The weight of the saturated acid minus the weight of SO_2 found gave of course the weight of the sulphuric acid in which the gas was dissolved, and from this was calculated its volume. These figures, together with the barometric pressure during the experiment, furnish the data for calculating the coefficient of solubility at the temperature of the experiment.

The capacity of the bottle was found, by weighing it empty, and again filled with distilled water of known temperature, to be 3.058 c.c.

The accompanying Table gives the principal observations and the results obtained at the different temperatures stated in the Table, the two results by the method of direct weighing being incorporated along with the rest for comparison. It will be seen that the solubility diminishes very rapidly as the temperature rises. The only figure which calls for any note is that representing the solubility at 1°C . This figure is permitted to remain, but is only an approximation to the truth, because the acid saturated at that low temperature was of course supersaturated at the ordinary temperature of the air, and I did not dare to weigh the bottle, lest the stopper should blow out and gas be lost, but plunged it at once under bichrome. The weight, and hence the volume of the sulphuric acid are, therefore, not known exactly, but the figure is probably not far from the truth.

I attempted now to determine the solubility in acids of different strengths at about the ordinary temperature. As the passage of dry gas through dilute acids involves the carrying off of a certain amount of moisture, and the consequent alteration of the composition of the acid, it would seem that the chemical method is here inapplicable, and I had recourse at first to a determination by direct weighing. A known quantity of the acid used was saturated in the apparatus originally used, and a weighed drying tube was attached to the exit tube during the passage of the gas, so as to catch any moisture carried off by the SO_2 .

This tube was again weighed at the end of the experiment, and from the gain in weight any alteration in the composition of the acid used could be easily calculated. Sulphuric acid being out of the question for the drying tube, I used at first the ordinary porous calcic chloride, but I found that that substance absorbed SO_2 , probably by simple mechanical diffusion into its pores, to such an extent, and that the SO_2 so absorbed was so slowly given off again, as to render the guard-tube quite useless. I found that by substituting pure fused chloride for the ordinary vesicular stuff this difficulty was avoided, and that the tube could be readily cleared of SO_2 by blowing dry air through for a minute after detaching the guard-tube from the apparatus.

The dilute acids used were prepared by mixing concentrated acid of 1.840 sp. gr. with water, and their composition was inferred from a determination of their specific gravity.

Two sets were prepared, the first by endeavouring to obtain acids containing about 20, 40, 60, and 80 per cent H_2O , while in the second set I aimed at producing acids containing some definite number of molecules of H_2O with each molecule of H_2SO_4 . The following Table gives the specific gravities and composition of these acids:—

Acid.		Sp. Gr.	Per Cent H_2O .
a	.. ..	1.703	.. 22.7
b	.. ..	1.482	.. 41.7
c	.. ..	1.300	.. 60.8
d	.. ..	1.139	.. 80.8
$\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$	.. ..	1.753	.. 18.3
$\cdot 2\text{H}_2\text{O}$	.. ..	1.626	.. 29.4
$\cdot 4\text{H}_2\text{O}$	.. ..	1.456	.. 44.2
$\cdot 10\text{H}_2\text{O}$	.. ..	1.257	.. 66.0
$\cdot 20\text{H}_2\text{O}$	.. ..	1.151	.. 79.3
$\cdot 50\text{H}_2\text{O}$	.. ..	1.067	.. 90.2

All of these last acids contain rather more water than corresponds to the formulæ assigned to them.

The results of these determinations are given in the Table (Experiments 10 to 19).

In the case of the more dilute acids, one or two of the weighings of the guard-tube exhibited anomalies which I found it rather difficult to account for, although I believe it was due to the water which had been caught in the tube taking up SO_2 in the stream of gas, and slowly giving it out again when the tube was filled with air. Although they were not very large, still they led one rather to doubt the figures obtained for the three most dilute acids. On examining the figures for the increase of the weight in the guard-tube throughout the whole series, however, I found that the amount of water carried away by the SO_2 in the course of an experiment was never sufficient, even with the most dilute acid, to render the composition of the acid at the end of the experiment perceptibly different from that at the beginning, and I therefore resolved to repeat some of the determinations by the chemical method. This was done, and the results (Experiments 20 to 26 in Table), show a very satisfactory agreement with those obtained by the other method, except in the case of the acid $\text{H}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, in which case I am inclined to trust entirely to the lower figure given by the chemical method, believing that the other is influenced by the source of error just mentioned.

On examining the figures for acids of different strengths, although, unfortunately, from the temperature not having been kept constant throughout the determinations, the results are not exactly comparable with one another, we notice at once, whether we compare the solubility in H_2SO_4 at 11° with the set of low-temperature determinations of acids a to d, or the solubility in H_2SO_4 at 16° with the coefficients for the other set of acids at near the same temperature, that the addition of water to H_2SO_4 at first lowers the solubility coefficient. A comparison of the figures for the acids H_2SO_4 , 1, 2, 4, &c., H_2O shows us that the coefficient diminishes rapidly on the

Number of Experiment.	Acid used.	Temperature. Centigrade.	Barometer. Mm.	Weight of Saturated Acid.	Specific Gravity at Temperature of Experiment.	Weight of SO ₂ absorbed.	Volume at Normal; c.c.	Weight of H ₂ SO ₄ .	Specific Gravity near 15° C.	Volume near 15° C.	Observed Coefficient.	Coefficient at 700 m.m.
1.	H ₂ SO ₄	17.0	—	—	—	—	—	—	—	—	—	28.14
2.	—	16.1	—	—	—	—	—	—	—	—	—	28.86
3.	—	11.1	752.9	5.5744	1.823	0.2763	96.36	5.2981	—	2.879	33.46	33.78
4.	—	26.9	763.5	5.5733	1.822	0.1632	56.92	5.4101	—	2.940	19.36	19.27
5.	—	42.0	770.4	5.5702	1.821	0.1057	38.60	5.4645	—	2.970	13.00	12.82
6.	—	50.9	773.3	5.5595	1.818	0.0822	28.68	5.4773	—	2.977	9.63	9.47
7.	—	62.3	766.6	5.5552	1.816	0.0622	21.71	5.4930	—	2.985	7.27	7.21
8.	—	84.2	759.4	5.5320	1.809	0.0388	13.55	5.4932	—	2.985	4.54	4.54
9.	—	1.1	753.4	—	—	0.4256	152.00	—	—	3.000?	50.67	51.11
10.	Acid (a)	9.8	760.0	—	—	1.0758	375.25	22.0135	1.703	12.926	29.03	29.03
11.	(b)	8.6	766.1	—	—	1.6522	576.20	21.2270	1.482	14.323	40.23	39.91
12.	(c)	6.9	759.6	—	—	1.8069	630.16	18.0645	1.300	13.895	45.35	45.38
13.	(d)	6.9	759.1	—	—	2.1699	756.75	17.7300	1.139	15.566	48.61	48.67
14.	H ₂ SO ₄ .H ₂ O	16.4	758.8	—	—	0.8064	281.23	23.5783	1.753	13.451	20.91	20.94
15.	.2H ₂ O	15.7	770.6	—	—	0.9515	331.84	20.9590	1.626	12.888	25.75	25.39
16.	.4H ₂ O	16.7	771.6	—	—	1.0690	372.81	18.5345	1.456	12.724	20.30	28.86
17.	.10H ₂ O	14.1	756.9	—	—	1.0412	363.12	14.1798	1.257	11.279	32.24	32.40
18.	.20H ₂ O	16.8	767.5	—	—	1.0082	351.61	12.6983	1.151	11.032	31.87	31.56
19.	.50H ₂ O	15.5	780.4	—	—	1.3112	457.28	12.9204	1.067	12.106	37.77	36.78
20.	.H ₂ O	15.0	752.0	5.3187	1.739	0.1739	60.63	5.1448	1.753	2.941	20.62	20.83
21.	.2H ₂ O	15.6	753.9	4.9203	1.609	0.2076	72.39	4.7127	1.626	2.898	24.98	25.17
22.	.4H ₂ O	15.1	747.4	4.4590	1.458	0.2435	84.92	4.2155	1.456	2.891	29.37	29.87
23.	.10H ₂ O	14.8	744.3	—	—	0.2468	86.07	—	1.257	2.880	29.87	30.52
24.	.10H ₂ O	14.8	749.8	3.9058	1.277	0.2493	86.94	3.6565	1.257	2.909	29.89	30.30
25.	.20H ₂ O	15.2	741.9	3.5860	1.173	0.2570	89.63	3.3290	1.151	2.886	31.06	31.82
26.	.50H ₂ O	16.0	755.4	3.3702	1.102	0.2812	98.07	3.0890	1.067	2.895	33.87	34.08

water so as to reach a minimum between H₂SO₄ and H₂SO₄.H₂O; this minimum occurs probably at H₂SO₄.H₂O, for which acid the coefficient is little more than two-thirds of that for H₂SO₄. On the further addition of water the coefficient again rises rapidly, though not quite so rapidly as it fell, so that the solubility in H₂SO₄.H₂O is almost the same as that in oil of vitriol. Beyond this point the coefficient slowly rises with dilution as far as the experiments go, and will, presumably, increase regularly until the coefficient for pure water is reached. Since these experiments were finished, I notice a quotation in "Watts's Dictionary" (3rd supplement), to the effect that Setschenow has determined the coefficients of solubility of CO₂ in sulphuric acids of different strengths, and that he finds that dilution of the acid brings down the coefficient rapidly from 0.932 for H₂SO₄ to a minimum of 0.666 for H₂SO₄.H₂O, whence again it slowly rises on further dilution until the coefficient for water is reached. It is interesting to note that not only does the minimum solubility of CO₂ correspond in position with that of SO₂, but the proportion which the minimum coefficient bears to that for H₂SO₄ is nearly the same in both cases. The determination of the solubilities of other gases in dilute sulphuric acids, and in other liquids which form definite hydrates, would seem to be a field of inquiry in which interesting results might be expected.

One other point requires to be mentioned. After most of the above determinations were finished I came upon a statement of Berthier (*Ann. Chim. Phys.* [3], 7, 77) which I had not previously noticed, in which he says that SO₂ colours potassic bichromate green from formation of chromic sulphate and hyposulphate. Evidently the incomplete oxidation of SO₂ to dithionite instead of to sulphuric acid would be a fatal defect in the method, and I at once set to work to discover whether this formation of dithionite took place in the determinations. I prepared some calcic dithionite by Welter and Gays-Lusac's method, and a determination of the loss on heating and of the SO₄ produced by fusing it with nitre showed it to be practically pure, only containing a trace of sulphate. A weighed quantity of this was added to 100 c.c. of

acidified standard bichrome solution, and left for a day, at the end of which time not the slightest alteration of colour could be detected. The liquid was then boiled for ten minutes, and titrated after cooling. Reduction had taken place to an extent which indicated the conversion of about half of the dithionite into sulphate. Although then the action is rather slow, it is clear that dithionates are oxidised by boiling bichrome solution. Two equal volumes of solution of SO₂ were now added, each of them to 100 c.c. of standard bichrome solution. In the first the SO₂ was immediately determined by titration with ferrous sulphate and bichrome, while the second was boiled for fifteen minutes and allowed to cool before titrating. Both gave exactly the same result. It is evident from this, coupled with the former experiment, that no dithionate can have been present, and that the SO₂ must have been completely converted into sulphate.

LAW OF THE CONGELATION OF THE AQUEOUS SOLUTIONS OF ORGANIC MATTERS.

By F. M. RAOULT.

THE apparatus employed in these researches is that which has already served for studying the point of congelation of alcoholic mixtures. The solution is constantly agitated; its temperature is slowly lowered some tenths of a degree below its point of congelation, and a portion of the same liquid, already frozen, is introduced. The supersaturation immediately ceases, and the ice appears in the form of little spangles, which multiply and float in the liquid. At the same time the thermometer rapidly rises to the normal point of congelation, and if the solution is dilute it remains absolutely steady for some minutes, after which the temperature falls again. There is then a minimum lowering below zero, and this minimum the author takes as the depression of the freezing-point. For one and the same solution this point is found always the same within about

1-100th of a degree, provided that the thermometer is immersed in the liquid and that the latter is constantly agitated.

The author has pointed out in the memoir cited that for solutions of alcohol not containing more than 1 equiv. per kilo. of water, the lowering of the freezing-point is proportional to the weight of alcohol dissolved in a constant weight of water. He has ascertained that the case is the same with solutions of methylic alcohol, formic and tartaric acids, and sugar. We may therefore admit that the law established by Blagden for the mineral salts is applicable to dilute solutions of organic compounds. The author has experimented upon twenty-nine bodies selected so as to be as different as possible in their solubility, their chemical function, their constitution, and their molecular weight. The lowering of the freezing-points per grm. of substance dissolved in 100 grms. of water vary considerably and in the proportion of 1:20. Nevertheless if we multiply the reduction of temperature corresponding to 1 grm. by the molecular weight of the substance, we find a product almost constant. This product ranges between 17 and 20. We may therefore say that the molecules of different organic compounds dissolved in the same quantity of water occasion substantially the same depression in the freezing-point. This tends to show that in most cases the molecules of organic compounds are simply separated by the act of solution, and brought to one and the same state, in which they exert the same influence upon the physical properties of water.

The determination of the freezing-point of the solutions of organic compounds acquires thus a great practical importance. It may serve to verify the purity of bodies, to find the strength of their solutions, and to trace the slow alterations thus produced. But its most important application will be the determination of the molecular weights in the numerous cases where the determination of the vapour-density is impossible. If it is necessary to decide between several molecular weights of which some are multiples of others, we select the one which if multiplied by the fall of temperature due to 1 grm. of the substance in question gives the product 18.5, this figure representing the mean molecular decrease of the freezing-point of organic matters. The author has not yet met with a soluble organic body for which this rule leads to an erroneous or even questionable result.—*Comptes Rendus*.

PRELIMINARY NOTE ON DIDYMIUM.

By P. T. CLÈVE.

In 1874 (*Bulletin*, xxi., p. 246) I determined the atomic weight of didymium, using an oxide in which the spectro-scope detected the presence neither of lanthanum nor of yttrium. As a mean I fixed the atomic weight at 147. Subsequently M. Brauner (*Sitzungsberichte K. Akad. Wissen. Wien*, Dec. 4, 1881) determined the atomic weight at 146.6, which differs little from the value which I ascertained. Chemists who had previously determined the atomic weight of didymium have found numbers approaching 144. Quite recently I have received from M. Brauner a letter in which he informs me that he has since found the number 145.4.

I have always during the last years suspected the presence of a new element accompanying didymium, and I have made repeated efforts to find it. In the beginning of this year I have submitted to fractionated precipitations about 200 grms. didymium oxide extracted from gadolinite, and separated from the yttria earths with potassium sulphate by repeated precipitations. The atomic weight of the fraction precipitated first was 146; that of the last fraction was 142.

The examination of the ignition-spectrum showed in the last fraction rather strong rays of didymium and lanthanum, but also new rays, among which is one very

strong, and possessing the wave-length $\lambda = 4333.5$, according to an exact determination by M. Thalén. This ray belongs neither to didymium, lanthanum, yttrium, erbium, terbium, or to the Y_a of M. Marignac.

The first fraction having the atomic weight 146 gave merely a feeble trace of this ray. It is therefore evident that the metal which gives this ray is more basic than didymium, but less so than lanthanum. Samarium is less basic than didymium.

Having submitted didymium chloride to a series of fractionated decompositions by heat, I have found the same ray in the fractions which best resist decompositions, but I have not found a trace in the first fractions.

I have found the ray in the spectrum of the fractions which have been precipitated with formic acid, whence it seems to result that the formiate is sparingly soluble like the formiates of didymium and of the oxides of cerite. The double salt with potassium sulphate must also be sparingly soluble.

The ray 4333.5 was already observed in 1868 by M. Thalén in a mixture of lanthanum and didymium obtained by M. Bahr. He was not able to detect it in 1874, when examining the didymium and lanthanum prepared by myself. Hence I had eliminated it by the reiterated fractionations to which I had submitted the lanthanum and didymium. The metal which produces this ray appears to accompany didymium in most metals. It has been found in the impure didymium extracted from hjelmite, monazite, eucolite, the orthite of Arendal, in cerite, and in gadolinite.

I have mentioned these facts to secure the right of continuing my researches upon didymium, for which I have made considerable preparations. I do not wish, however, to hinder chemists who, fortunately for science, are occupying themselves with the chemistry of the rare earths from pursuing their researches. On the contrary, I shall be satisfied if the facts pointed out above prove of service to them in their investigations. As it seems to me, there still exists an unknown element accompanying didymium, and not to give it a name, I propose to designate it provisionally as $Di\beta$, characterised by the strong ray $\lambda = 4333.5$.—*Comptes Rendus*.

SOME POINTS IN THE CONSTRUCTION OF AN APPARATUS FOR THE ACCURATE ANALYSIS OF GASES.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

A. WHEN a certain method of determining the top of the pressure column is used, the conditions of most accurate measurement of varying volumes of gas are satisfied by making the column of mercury, which measures the pressure, equal in length to the part of the eudiometer which is filled with gas. In the usual form of the apparatus, the pressure column has to be longer, which immensely increases the difficulty of securing uniformity of temperature.

B. To define the top of the pressure column, I use a Jolly-point enclosed in the barometric vacuum; this makes the probable error at the top of this column evanescent. The whole error of the tension is therefore produced by the same uncertainty which produces the error in the observed volume. If now the Jolly-point is put at about the level of the top of the eudiometer tube, the probable error of the tension is the same part of the tension as the probable error of the observed volume is of the observed volume. This is the condition of the maximum accuracy.

C. To preserve the barometric vacuum over the pressure column, I shut off this column from communication

* *Proceedings of the American Association for the Advancement of Science*, vol. xxix., Boston Meeting.

with the rest of the apparatus except at the instant of a measurement. The screw of the fine adjustment formerly described serves also this purpose. The vacuum is found to be even more permanent than that of a barometer.

D. An auxiliary pressure tube is employed for preliminary adjustment. The bore of this tube is but a millimetre, which secures two important advantages.

E. The eudiometer tube is graduated with fine lines not over the eight-thousandth of an inch wide, in half millimetres. The graduation is affected with no relative errors of the hundredth of a millimetre. A reading microscope is carried on a cylinder so solidly connected with the iron tripod of the apparatus that ten pounds produce a relative flexure of only a tenth of a millimetre. This microscope is brought nearly to the level of the mercury in the eudiometer when the column in the pressure tube reaches just to the Jolly-point. The microscope is made to give distinct vision of the graduation, and by Grunow's cathetometer fine adjustment, the terminal lines of the eye-piece micrometer are made to coincide with two millimetres of the graduation. The focussing movement now moves the microscope so that distinct vision is had of the meniscus, and the level of the mercury is read to the hundredth of a millimetre on the eye-piece micrometer, whose divisions now represent the divisions of the tube carried forward into its interior. A four inch objective, with an amplification of about sixty diameters, is thus utilised.

F. The probable error of this reading of the level of the meniscus cannot be separated from other probable errors incident to the observation, but the sum total of all the errors whatever is equivalent to no more than a probable error of one-hundredth of a millimetre in this determination; and in the calibration of the apparatus, made before much practice in the use of this reading arrangement, the probable error of a reading was the hundredth of a millimetre.

G. The probable error of a single determination of oxygen in air is less than the four-hundredth of one per centum.

H. The method of measurement is adapted to rapid computation. The whole reduction of three measurements in an analysis, so as to get the per centum of oxygen, takes less than two and a half minutes.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 15, 1882.

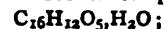
Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—J. Ferrier, J. Hodgkin, W. O. Nicholson, H. H. Robinson, G. H. Sharpe, G. Tarmay. During the evening a ballot was held, and the following gentlemen were declared by the Scrutators, Dr. Japp and Mr. J. M. Thomson, duly elected Fellows of the Society:—R. Alexander, B. Brauner, J. J. Dobbie, C. J. Ellis, W. L. Goodwin, D. E. Johnstone, T. W. Lovibond, R. W. Pullar, R. N. Wolfenden.

THE PRESIDENT then called on Mr. C. E. GROVES to read a paper entitled "*Note on β -Naphthaquinone.*" See p. 267.

Mr. A. G. PERKIN then read a paper entitled "*Contributions from the Dye-house of the Yorkshire College: On some New Compounds of Brasilein and Hæmatein.*" by J. F. HUMMEL and A. G. PERKIN. Commercial logwood extract is dissolved in hot water, and on cooling, ammonia is added in slight excess. This solution is exposed to the air for two or three days, or air is aspirated through for several hours. A dark purplish granular precipitate of the ammonia compound of Hæmatein is gradually

deposited. This precipitate is collected and pressed, 40 grms. are dissolved in a litre of hot water, and 30 to 160 c.c. of acetic acid (sp. gr. 1.04) added. The solution is heated for some time on a steam bath, and then allowed to cool. The amorphous residue of Hæmatein is filtered off, re-extracted with hot dilute acetic acid several times, and the combined filtrates evaporated on the steam bath, when glittering crystals of Hæmatein separate out. These are filtered off, washed with acetic acid, then with water, and dried. Thus prepared, Hæmatein is sparingly soluble in water, alcohol, ether, and acetic acid; it dissolves readily in alkalis. Analyses indicated the formula $C_{16}H_{12}O_6$. The crystals are evidently identical with those described by Haberstadt and Reis (*Ber.*, xiv., 611). Hæmatein is destroyed by hot sulphuric acid; it, however, dissolves readily in cold concentrated sulphuric acid, producing a dark reddish brown solution. By adding hot glacial acetic acid very gradually to this solution until it is diluted to the extent of two or three times its bulk, an orange crystalline precipitate is gradually thrown down. This, on analysis, gave the formula $C_{16}H_{12}O_6SO_3$. The authors suggest the name sulphate of hæmatein; it is insoluble in alcohol, ether, and benzol, but is slightly soluble in strong acetic acid and cold ammonia. By digesting this substance with water and alcohol, a reddish brown crystalline powder was obtained, having the probable formula $(C_{16}H_{12}O_6)_3SO_3$. By the action of hydrochloric acid in sealed tubes on Hæmatein a body was prepared having the formula $C_{16}H_{11}O_5Cl$, crystallising in minute scarlet needles. By the action of hydrobromic acid a similar substance containing bromine was obtained. From commercial Brazil extracts, by a similar process to that employed in the preparation of Hæmatein, Brasilein was obtained; dried at 100° its composition is—



dried at 130° it was obtained anhydrous. By the action of sulphuric, hydrochloric, and hydrobromic acids, compounds were prepared corresponding to those prepared from Hæmatein. The tinctorial power of these new compounds is much greater than that of the original Hæmatein and Brasilein, and the colours are much faster. Although the authors did not form from Hæmatein a body similar to the cœrulein obtained from gallein, they are of the opinion that Hæmatein probably belongs to the class of phthalleins.

Mr. WARINGTON then read a paper "*On the Determination of Nitric Acid as Nitric Oxide by means of its Reaction with Ferrous Salts (Part II.)*." The author described and exhibited the apparatus at present employed by Schlösing. The nitrate mixed with ferrous chloride and hydrochloric acid is introduced into a very small tubulated retort, the extremity of which dips under mercury. The air is expelled by a stream of carbonic acid. The retort is then boiled for eight minutes, and the gas evolved collected in a small jar containing caustic potash. This nitric oxide is converted into nitric acid by treatment with water and oxygen, and finally titrated with alkali. The method fails, however, with extremely small quantities of nitrates and in the presence of certain kinds of organic matter. The prejudicial effect of the organic matter is removed to some extent by boiling the contents of the retort to dryness, but with very small quantities of nitric acid the results were still too low. The author, by various improvements and modifications described below, has been able to estimate 98 to 100 per cent of the nitrogen, even when half a milligramme of nitrogen as nitre was used. Perfect exclusion of oxygen from the apparatus is essential. This is effected by mixing the hydrochloric acid used in the carbonic acid generator with cuprous chloride, and protecting its surface with a layer of oil. The carbonic acid is always kept under pressure, so that any leak must be outwards. The nitric oxide is estimated by gas analysis, preference being given to absorption over caustic potash, after successive treatments with oxygen and pyrogallol. In the introduction of the oxygen a gas delivery tube is—

vented by Prof. Bischof was found of great service. It consists of a test-tube, with a minute perforation about $\frac{1}{4}$ inch from the mouth. The tube being filled with gas, has its mouth closed by an india-rubber cork, through which passes a short glass tube with a fine orifice. On tilting the tube under mercury with the perforation downwards, minute bubbles of gas rise from the perforated stopper closing its mouth, and thus the quantity added can be regulated with great accuracy.

The SECRETARY then read a paper "On a New Process of Bleaching," by J. J. DOBBIE and J. HUTCHESON. The authors give a *resumé* of the history of the use of chlorine for bleaching. They then give an account of some experiments in which they have generated the chlorine by the electrolysis of dilute hydrochloric acid. The most satisfactory liberation of chlorine was obtained with a low battery power. In all cases Turkey red cloth was used as the fabric to be bleached. The best results from a practical point of view were obtained by steeping the cloth to be bleached in sea-water and passing the fabric between a series of carbon rollers, the upper row of which was connected with one pole, the lower row with the other pole of a battery. The rollers were caused to rotate slowly, and thus pass the fabric from one end to the other. Hypochlorite is formed, and on subsequent immersion in acid the fabric is effectually bleached. It was found that when hydrofluoric acid was substituted for hydrochloric acid bleaching also took place.

The Society then adjourned over the summer recess.

PHYSICAL SOCIETY.

June 17, 1882.

The Physical Society met in Oxford by invitation of the President, and, after luncheon in the Hall of Merton College, by kind permission of the Warden and Fellows, the health of the Society was proposed by the President and responded to by Lord Rayleigh.

The usual meeting was then held in the Clarendon Laboratory, Professor CLIFTON, President, in the chair.

Dr. W. H. STONE exhibited and described an electro-dynamometer, specially designed for measuring the currents used in the medical applications of electricity. For this purpose a light suspended coil is an advantage, and Dr. Stone adopted aluminium, which, with equal conductivity to copper, weight for weight, is very much lighter than copper. No frame was used for the coil, which was tied up with silk and varnished, amber varnish such as used by photographers being recommended by the author for this and similar purposes as preferable to shellac. A bifilar suspension of the coil was adopted to give directive force to the coil, the threads being of silver-gilt wire drawn after gilding, and such as is used in making gold lace. It is preferable to platinum wire by reason of its lower resistance. Silver-gilt wire $\frac{1}{5000}$ inch in diameter has a resistance of 9.8 ohms per metre, whereas platinum of same dimensions measures 62.2 ohms. Aluminium wire can be drawn as fine as copper. Some difficulty has hitherto been experienced in making contacts with it for electrical purposes, but Dr. Stone believes he has overcome these. The gilt wire makes a good contact with it. The specific heat of aluminium is high, and hence it is recommended by the author for resistance coils. The threads of the suspension were hung from two little brass springs placed horizontally in line and capable of being adjusted to and fro so as to widen the distance between the points of suspension when necessary.

Mr. Varley, Prof. Perry, and others, offered some remarks.

Mr. BOSANQUET then described his application of the Faure accumulator charged by a dynamo-electric generator to the working of laboratory apparatus instead of the usual Grove or other battery. The net result of his experiments is that the accumulators charged for two hours

have sufficient energy to keep the apparatus employed running for a week, and hence it is unnecessary for him as heretofore to put up 30 Grove cells each day.

Prof. PERRY observed that a well-made Faure cell having the minium laid on in a uniform coat does not loose its charge nor develop local action as is done by those accumulators in which the minium is put into holes in the plates.

Prof. W. G. ADAMS then took the chair, while Prof. CLIFTON described some ingenious devices adopted by him in lecture experiments on electrostatics. These consisted of insulating glass stems with glass cups to hold sulphuric acid formed on the stems; also a form of key which by rapidly succeeding contacts brings the spot of light on the electrometer scale to rest without tedious swinging. He also described a form of lecture galvanometer, sine or tangent, which could be readily shewn in all its working to a large class, and exhibited a simple and inexpensive apparatus for measuring the focal length of a lens in six different ways according to what is known about the lens. The results showed that the apparatus was very accurate in its indications.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 23, June 5, 1882.

Double Salts Prepared by Fusion.—MM. Berthelot and Ilosvay.—A thermo-chemical paper, not capable of useful abstraction.

Boiling-Point of Selenium.—L. Troost.—The author's experiments give numbers between 664° and 666°, whence he accepts 665° for the boiling temperature of selenium at pressures near to 760 m.m.

A Calorimeter by Refrigeration.—J. Violle.—The method of mixtures is certainly the most convenient for the measurement of a specific heat. Yet when the initial temperature of the body is comprised between 100° and 400° or 500°, special difficulties are met with which do not occur either higher or lower. In this interval the method of refrigeration would be precious if sufficiently exact. The following process seems to combine exactitude and simplicity: The author takes a small bottle of thin glass with a narrow neck and a double covering, between the two layers of which a good vacuum has been made before sealing the outer covering. The apparatus thus carries with it its own recipient, and the conditions of refrigeration remain always the same. By the neck of the bottle is introduced along with the thermometer an agitator, by means of which a constant temperature is introduced into the whole mass. In this manner are avoided those differences between the surface and the centre upon which the refrigeration method has hitherto been ship-wrecked.

Determination of the Specific Heats of Small Quantities of Substances.—MM. Thoulet and Lagarde.—This memoir cannot be intelligibly reproduced without the accompanying illustration.

A New Condensation Hygrometer.—A. Crova.—The author has found serious discrepancies between the results obtained respectively by Regnault's hygrometer and the psychrometer. In calm weather and in mean hygrometric conditions the two methods agree approximately, though Regnault's instrument shows lower indications. In a high wind and in low hygrometric conditions the discrepancy becomes enormous. The author describes an apparatus which he has had constructed by

which the dew-point can be found to 1-roth of a degree, independent of the agitation of the air.

Law of the Congelation of the Aqueous Solutions of Organic Substances.—F. M. Raoult.—See page 272.

Method for Determining the Ohm.—J. Joubert.—A mathematical paper, not capable of useful abstraction.

Influence of the Positive Electrode of the Battery upon its Chemical Work.—D. Tommasi.—The author has established the remarkable fact that the electromotor force of one and the same element may vary according as its positive electrode is of platinum or of carbon. An element, for instance, incapable of effecting the electrolysis of water or of a saline solution, although the calories liberated by the element were more than the calories absorbed by the decomposition of the electrolyte, if its positive electrode was of platinum, but became able to produce this decomposition if the positive electrode was of carbon. This fact has a great importance as regards the relation which the author seeks to establish between the calories evolved by the battery and those absorbed by the decomposition of the electrolyte, and he has accordingly examined it in detail. A magnesium-platinum element in dilute sulphuric acid ought, according to thermic data, to decompose water, but the decomposition does not take place. It is the same if we substitute copper or silver for the platinum of the battery, but if we employ in the same element a cylinder of graphite or retort-coke as a positive electrode the electrolysis is effected. According to M. Berthelot (*Comptes Rendus*, 1881, Nov. 7) two zinc-platinum elements in dilute sulphuric acid should not decompose a solution of potassium sulphate, but the author on employing two zinc-coke elements in dilute sulphuric acid has succeeded in electrolysing a saturated solution of potassium sulphate with a brisk escape of gas at the two platinum electrodes, and transference of the acid to the positive electrode, and of the base to the negative electrode, and this in a few minutes and at the common temperature. According to M. Berthelot this electrolysis should require at least 103 calories, whilst it is actually obtained with 76 calories, and even less. A single zinc-coke element in dilute sulphuric acid decomposes potassium sulphate if the electrode of the voltameter is of copper, but not if it is of silver. The author has submitted several salts to electrolysis; the solutions all contained an excess of salt. The platinum wires of the voltameter were 0.4 m.m. in diameter, and plunged into the liquid to the length of 0.3 to 0.4 metre. The carbons employed were graphite or coke, previously heated to redness, and allowed to remain for six hours in contact with carbonic acid. The presence of this gas in the pores of the carbon retards polarisation, and renders the action more intense and more lasting. The author's results may be briefly summed up as follows:—Two zinc-coke elements (=77.4 cal.) decompose solutions of magnesium, zinc, cadmium, copper, manganese, and iron (ferrous) sulphates, and potassium chloride, bromide, and iodide.

Zinc Oxy-chloride.—G. André.—The association of zinc chloride with zinc oxide gives rise to hydrated oxy-chlorides, which are formed with liberations of heat varying but little.

Action of Carbon Disulphide upon Silicium.—A. Colson.—The author obtains a compound, $\text{Si}_4\text{C}_4\text{S}$, which, if heated in a current of oxygen, gives off sulphurous acid, and is transformed into $\text{Si}_4\text{C}_4\text{O}_2$ without change of weight. In these compounds the carbon cannot be detected by the usual means. There are obtained in contact with siliceous tubes bodies more oxygenated in a reducing atmosphere than in an oxidising one. The sulphur is tetratomic.

Preliminary Note on Didymium.—P. T. Clève.—See page 273.

A New Mono-chlorinated Camphor.—P. Cazeneuve. Mono-chlorinated camphor has an odour like that of

camphor, a bitter and aromatic taste. It is more soluble in water than camphor or its bichlorinated compound. It is soluble in alcohol, ether, chloroform, carbon disulphide, and benzol. It melts at 83° to 84° , begins to solidify at 83° , but remains soft above 80° . It boils at 244° , and distils almost without decomposition at from 244° to 247° .

Spontaneous Fermentations of Animal Matters.—A. Béchamp.—The author considers that the microzymas in organisms are the agents chemically and physiologically active in the transformations which are effected during life and after death.

Die Chemische Industrie.

Vol. 5, No. 4.

Behaviour of Hyponitric Acid with Sulphuric Acid and the Process of Lasne and Benker in the Sulphuric Acid Manufacture.—G. Lunge.—Lasne and Benker have indicated a process which is to effect a great economy in the consumption of nitre, and which is theoretically based on the feeble affinity of hyponitric acid for sulphuric acid, and the ease with which the former is expelled from the latter. They assume that as the gases issuing from the chambers contain at least 5 per cent of oxygen, all the oxides of nitrogen present must be in the state of hyponitrous acid, which, as it is completely expelled from its combination with sulphuric acid at common temperatures by a current of common air, or preferably of carbonic acid, is not absorbed in the Gay-Lussac tower. The absorption of the bulk of the nitrogen compounds in the Gay-Lussac tower is only to be explained by the presence of sulphurous acid, which converts the N_2O_4 into N_2O_3 , and the loss of nitre may be reduced to one-third if a sufficiency of sulphurous acid and aqueous vapour is allowed to mix with the gases at the foot of the Gay-Lussac tower. The author considers the assumption that the nitrogen compounds in the chamber gases are exclusively present as hyponitric acid not proven and improbable, and the supposition that the latter acid forms an unstable compound with sulphuric acid at 62°B , decidedly erroneous. Prof. Lunge's experiments show that hyponitric acid is readily and completely absorbed by sulphuric acid at 60°B , and the colourless solution formed is neither changed by prolonged heating to about 100° , nor by prolonged treatment with air, but behaves exactly like a mixture of sulphuric acid, nitrosyl-sulphuric acid, and nitric acid. This holds good at least up to the proportion of 10 m.g. nitrogen per c.c. of acid, which represents a very strong nitroae. But though the theory of Lasne and Benker is inaccurate, the introduction of sulphurous acid may be advantageous on other grounds, especially in establishments which work with imperfect plant, e.g., if the absorption-space in the Gay-Lussac tower is too small or the excess of air is too large, in which case much nitrous acid escapes unabsorbed. By introducing sulphurous acid a part of the chamber-process is transferred to the tower. A favourable action of the sulphurous acid is conceivable from another point of view. If the Gay-Lussac tower is too wide, not all the molecules of the nitrous gas come in contact with the acid. Sulphurous gas if introduced will mix with the nitrous gases which are escaping between the falling drops of acid and retain them. But if an excess of sulphurous acid and watery vapour are present, the nitrosyl-sulphuric acid may be denitrated, and nitric oxide escape, thus causing a serious loss of nitrogen compounds.

Cosmos Les Mondes.

No. 3, May 20, 1882.

True Chemistry.—E. Maumené.—The author quotes and criticises a communication by M. Schützenberger (*Comptes Rendus*, p. 534) on the action of iodine and naphthalene. He considers that the reaction, of which the

Collège de France has made a misinterpreted study, shows that the principal action of iodine and naphthaline, necessarily beginning by the removal of hydrogen, does not give in any case $(C_{20}H_6)_x$, or "naphthaline less two atoms of hydrogen." The reaction leads immediately to a substitution, and the production of $C_{20}H_7I$. He considers that classical chemistry is, in theory, nothing but a long series of errors.

No. 4, 1882.

This issue does not contain any original chemical matter.

No. 5, 1882.

Certain Compounds of Nitrogen.—M. Maumené.—The compound $HCl.H_2N$, which the author can now form at the rate of 1 kilo. daily, has not the appearance of sal-ammoniac, and rather approaches potassium cyanate. If heated with potassa or soda it disengages a gas, H_2N , the odour of which is distinct from that of ammonia, and which is only about half as soluble in water. HN can also be easily obtained; it is a non-alkaline gas, almost insoluble in water, extinguishes bodies in combustion, and may be confounded with nitrogen.

in the matter of Letters Patent granted to Carl Daniel Ekman of Sweden, but now of 571, Old Broad Street, in the City of London, for the invention of "An improved method of treating wood in order to obtain fibre suitable for paper making and other purposes," bearing date the 13th day of July, 1881, No. 3062.

NOTICE IS HEREBY GIVEN that the said Carl Daniell Ekman has applied by Petition to the Commissioners of Patents for Inventions for leave to file in the Great Seal Patent Office with the Specification of the said Letters Patent a Disclaimer and Memorandum of Alteration of certain parts of the said Specification, and any person intending to oppose such application must leave particulars of objection thereto at the office of the Solicitor-General, No. 11, New Court, Carey Street, London, within 21 days from the date of the "London Gazette" in which it is published.

And **NOTICE IS HEREBY ALSO GIVEN**, that after the expiration of the said 21 days no objection will be received or entertained, and the Solicitor-General will proceed to a hearing.—Dated this 23rd day of June, 1882.

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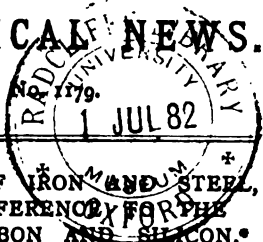
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THE CHEMICAL NEWS.

VOL. XLV. No. 179.



ON THE ANALYSIS OF IRON AND STEEL,
WITH SPECIAL REFERENCE TO THE
ESTIMATION OF CARBON AND SILICON.*

By FRANCIS WATTS,

Student in the Chemical Laboratories of the Mason Science College,
Birmingham.

NOTWITHSTANDING the large amount of attention which has been given by chemists to the perfecting of the methods adopted for the estimation of the carbon and silicon in iron or steel, there remains much to be desired in reference to the processes for the estimation of the so-called "combined" carbon, and especially for the estimation of the silicon. Some doubts have arisen as to the condition in which the latter element occurs in iron; that is to say, it appears to be believed by some chemists that the silicon occurs in iron and steel in a state of chemical combination with the iron, forming a silicide, whilst others appear to favour the view that at least a portion of it exists there in a condition corresponding to that of graphite. Whatever may be the truth in regard to this point, it is certain that when a specimen of cast-iron, wrought-iron, or steel is treated with an acid, the insoluble residue generally contains a portion of the silicon in an unoxidised condition.

The processes commonly adopted for the estimation of silicon in general depend upon the conversion of the silicon into its oxide by the action of acids or of bromine or iodine, and the oxidation of the unoxidised silicon of the residue, either by roasting or by fusion with nitre. Another, and for certain purposes an excellent, process, proposed by Boussingault, consists in roasting a weighed portion of the iron in a muffle, whereby the iron is converted into oxide, the silicon into silica, and the carbon is burnt off. On subsequently exposing this mixture of oxides to the action of hydrochloric acid gas at a red heat, the iron is volatilised in the form of chloride, whilst the silica which remains in the boat can be weighed.

In none of these processes, however, is any distinction observed between the silica which results from the oxidation of the silicon and that which exists ready formed in combination with various bases in the form of mechanically intermingled slag or cinder. That this distinction is of real importance there can be no doubt, but no serious attempts have been made to get over the difficulty. In the usual process the slag, if present, is sure to be more or less decomposed by boiling with the acid, and the silica thus liberated goes to augment the quantity of that from which the proportion of silicon is calculated. If, as is sometimes the practice, the residue is boiled with solution of sodium carbonate, with the object of dissolving away the silica from the graphite and slag, an uncertainty is introduced into the result, from the impossibility of avoiding the introduction of more or less silica with the alkali, and also from the difficulty of operating without loss upon so small a quantity of material.

Bromine and iodine have both been suggested as substitutes for acids, and these agents do not act upon the slag, but the precautions to be taken and the length of time occupied make the operations very tedious.

For the estimation of the total carbon, the following methods have been generally adopted:—

1. Combustion of a weighed quantity of the iron in a porcelain tube in a stream of oxygen. The chief

objection to this process is the very high temperature required.

2. Combustion of the carbon in the residue, left when iron is dissolved by the aid of iodine in the presence of water, but the length of time required for solution is a great objection to this method.
3. The total carbon is frequently estimated by dissolving the iron in a solution of copper chloride or sulphate. The whole of the carbon is left in the residue. The presence of the finely-divided metallic copper with which it is mixed is rather an advantage than otherwise, for it assists the combustion of the graphite—a matter of some difficulty. The chief defect in this otherwise excellent process is that unless the vessel containing the iron undergoing solution is kept very cool, a decided smell is perceptible, probably indicating the evolution of hydrocarbons. The time required for solution, too, is somewhat lengthy.
4. Weyl's method for determining the total carbon is a modification of the above process, and consists in attaching a lump of the iron to be analysed to the positive pole of a battery, of one Daniell's cell, the negative pole consisting of a piece of platinum foil, the menstruum as before being a solution of a copper salt. But even in this case it is difficult to prevent the evolution of gas from the iron.
5. Lastly, the method of Wöhler, to which further reference will be made presently, consists in heating a weighed portion of the iron in chlorine gas, whereby the iron is volatilised as chloride; the residual carbon can then be submitted to combustion in the usual manner.

At Dr. Tilden's request I have undertaken some experiments with the object of avoiding some of the difficulties just referred to. Our first desire was to secure a process by which silicon could be rapidly and easily determined in iron and steel, and at the same time distinguished from the slag, which is almost invariably mechanically intermingled to a greater or less extent.

The action of chlorine at a red heat presented itself as a reaction which might be turned to account for this purpose, and after some preliminary trials the following process has been adopted:—

Divested of details it is briefly this. The total carbon is first determined by Wöhler's method, with the precautions to be described hereafter. Another weighed portion of the iron is similarly treated in a stream of chlorine, whereby not only the iron but the silicon, and probably the sulphur and phosphorus, are volatilised in the form of chlorides; the gas as it issues from the combustion tube is caused to bubble through water contained in a flask; the water in the flask immediately decomposes the silicon tetrachloride, which is carried forward with the excess of chlorine, and soluble silica results. The water is afterwards evaporated to dryness, and the silica recovered and weighed. Unfortunately the presence of manganese is the source of a little difficulty, for its chloride is not sufficiently volatile to be readily removed from the contents of the boat, by the stream of chlorine. Hence, when manganese is present, which is almost always the case, it is necessary to wash the residue in the boat before weighing. The residue, which consists of the total carbon and the slag, having been weighed, from this weight, the weight of total carbon previously determined is deducted, the difference being the amount of slag. Thus, in two simple and rapid operations, are determined, first, the total carbon; second, the silicon and slag.

Regarding the process more in detail, the following arrangements are recommended:—

It being necessary to obtain an efficient supply of chlorine which shall be well under control, some modification of the usual apparatus for generating the gas becomes desirable. A Wolff's bottle is filled with manganese ore in lumps; the necks are fitted with

* Read at a Meeting of the Philosophical Society of Birmingham, May 11, 1882.

one of which passes to the bottom of the bottle, the other passes just through the cork, and is provided with a glass stopcock. The bottle is placed in a saucepan of water, arranged so that it can be heated. The longer tube is connected with a stoneware jar containing common strong hydrochloric acid, this jar standing on a higher level than the generator; a gentle heat being applied to the saucepan, a supply of chlorine is obtained which may be regulated at will. The stoppers should be of india-rubber, well coated over with paraffin.

The chlorine, before entering the combustion-tube, must be rendered perfectly free from air and moisture. To effect this the gas is passed through three wash-bottles, the first containing water, the others strong sulphuric acid. The oxygen is removed by passing the gas through a tube containing lamp-black, which has been strongly heated in a crucible for half an hour to free it from moisture and tarry matter, as well as to render it more coherent; the column of lamp-black is kept in position by plugs of gas carbon, and should be about 6 or 8 inches long, occupying only the central portion of the tube. In practice it was found that the chlorine always contained moisture after passing through this carbon tube, and to this cause the discrepancies in the amounts of silicon found in the earlier analyses were probably due, for it is of the highest importance that the combustion-tube should be quite dry. Much better results were obtained when a tube containing pumice moistened with strong sulphuric acid was introduced between the carbon tube and the combustion-tube.

The only part of the apparatus remaining to be described is the combustion-tube. This is a piece of ordinary combustion-tube, a portion of which, some five or six inches, is bent downwards, not drawn out, at an angle of about 110° , so as to conveniently dip into a flask about a third filled with water. The carbon-tube, together with the drying and combustion tubes, must be arranged to lie within the gutter of the combustion furnace,* the bent portion of the combustion-tube turned downwards and dipping into the flask placed at the end.

Having described the apparatus employed in this process it now remains to give an account of the method of procedure.

About 0.6 or 0.8 grm. of cast-iron, or about three times that quantity of wrought-iron or steel, in the form of borings, small lumps, or wire, is weighed in a porcelain boat; this is then introduced into a straight combustion-tube, taking care that the carbon in the carbon-tube is heated fully to redness, and the air in the apparatus and combustion-tube quite displaced by chlorine before the boat is heated. A slow stream of chlorine is steadily maintained and the boat heated gently, just sufficient heat being applied to volatilise the ferric chloride as it is formed. The stream of chlorine must not be too rapid or there is a danger of particles of carbon being carried out of the boat. When the whole of the iron is removed the boat is taken out whilst still warm, allowed to cool, thus becoming freed from any traces of chlorine, and the carbon determined by combustion, in a separate tube, in oxygen in the usual way.

A similar quantity of the iron is weighed in another boat and the bent combustion-tube placed in the furnace, care being taken to free it entirely from any moisture. A flask of about 500 c.c. capacity containing about 100 or 150 c.c. of distilled water is arranged so that the extremity of the combustion-tube dips under the water; the air is carefully removed from the apparatus by passing a stream of chlorine, and the carbon-tube strongly heated. The boat is now introduced and the chlorine allowed to flow for a few minutes before heating; a gentle heat is now applied as in the previous instance, a higher temperature being induced towards the end of the operation.

When the whole of the iron is volatilised, a point most readily ascertained by the disappearance of red vapour,

the tube is allowed to cool, the stream of chlorine being maintained for a short time, and the boat and flask removed. On removing the boats they should in every case be at once placed in weighing tubes to preserve them from accident. The water is boiled whilst still in the flask, until free from chlorine, and then evaporated to complete dryness in a platinum dish, in the water-bath, the residue treated with a few drops of hydrochloric acid, well washed with warm water upon a filter, and ignited and weighed. This, less the filter-ash, gives the weight of SiO_2 , from which the percentage of silicon can at once be calculated. Should any silica adhere to the extremity of the combustion-tube it may be detached by a glass rod, the extremity of which is covered by a short length of india-rubber tubing, a few drops of solution of caustic potash being employed if necessary.

A filter is dried at 110°C. , enclosed in weighing tubes, and its weight ascertained; the contents of the boat are now emptied into this, well washed with hot water, and again dried at 110°C. and weighed. This is the weight of the mixed total carbon and slag, the percentage of which must be calculated. From this the percentage of total carbon already determined is deducted and the remainder reckoned as slag. The proportion of slag can be checked by burning off the carbon from this mixture and weighing the residue. The object of washing the carbon and slag is to remove the less volatile chlorides. Earlier experiments, in which the washing of the residue was omitted, were far from satisfactory, for it was found impossible to entirely volatilise the chloride of manganese, which, when the boat and its contents were ignited in oxygen, formed black glittering crystals of oxide upon its sides.

The process which has just been described appears at first sight to be complicated, but when the operator has a number of analyses to perform and is provided with two combustion furnaces, and the chlorine apparatus is once mounted, nothing is easier to carry out. The method enables the analyst to distinguish absolutely between the elemental and the oxidised portions of the silicon, and is specially distinguished for the short amount of time occupied. The removal of the iron from the sample by chlorine is accomplished in about quarter of an hour, and the combustion of the residue can be proceeded with immediately, as it is not necessary nor desirable to allow the combustion-tubes to cool down completely between the successive operations.

The only obvious source of error was at the outset enquired into and found not to exist. It was thought possible that on treating such a mixture as cast-iron contains of silica and graphite in chlorine gas a reaction would ensue leading to the evolution of carbonic oxide and silicon chloride. But a blank experiment upon a mixture of finely powdered blast-furnace slag and crystalline graphite, showed that the mixture sustained no loss of weight by heating in chlorine gas and no silica was found in the receiver.

The statements of different analysts concerning the proportions of slag in different varieties of pig-iron are so discordant among themselves that it appeared desirable to ascertain by direct experiment whether some of the other constituents of slag could not be recognised. Accordingly a specimen of No. 1 Staffordshire hot-blast pig was carefully bored under my own superintendence and the borings collected so as to be entirely free not only from dirt but from the sand adherent to the exterior of the pig. A portion of these borings was analysed. After prolonged treatment with aqua regia the insoluble residue dried at 120°C. , and consisting chiefly of a mixture of carbon and silica, amounted to 14.9 per cent. The chlorine process indicated 4.4 per cent of slag. A portion of the same iron dissolved in acid and the solution tested qualitatively for calcium gave decisive evidence of its existence. Aluminium, however, could not be detected.

The following analyses have been selected to illustrate the results obtained by this process, and different varieties of iron :—

* One of Griffin's long combustion furnaces was used.

PERCENTAGE OF SILICON AND SLAG.

Description of Iron.	Weight of Iron taken.	Weight of Washed Residue = C+slag.	Percentage of C+slag.	PERCENTAGE OF SLAG.	Weight of SiO ₂ obtained.	PERCENTAGE OF SILICON.
<i>Cast-Irons.</i> —						
I. White Staffs. . . .	0.8860	0.0278	3.13	0.74	0.0122	0.64
II. No. 1 Hematite . . .	0.8734	0.0363	4.04	0.07	0.0415	2.21
III. No. 1 Hot-Blast Staffs.	—	—	—	4.40*	0.2087	3.96
IV. No. 2	0.4265	0.0174	4.08	0.62	0.0283	3.09
V. No. 3	0.5562	0.0219	3.90	0.84	0.0488	4.09
VI. Iron Wire	3.3485	—	—	—	0.002	0.03
Do. by nitric acid process	3.5513	—	—	—	0.0018	0.024
VII. Steel Wire	0.5927	—	—	—	0.0044	0.34

* This proportion of slag appears enormous, but, as already stated, the residue left when this iron was dissolved in *aqua regia* amounts to 149 per cent. It appears to be an exceptional case.

PERCENTAGE OF TOTAL CARBON.

Variety of Iron.	Weight of Iron taken.	CO ₂ obtained.	Percentage of Carbon.
<i>Cast-Iron.</i> —			
I. White Staffs. . . .	0.6947	0.0603	2.39
II. No. 1 Hematite . . .	0.7945	0.1159	3.97
III. No. 1 Hot-Blast Staffs. (By electrolysis).	—	—	3.15
IV. No. 2 Hot-Blast Staffs.	0.5307	0.0675	3.46
Do.	0.6567	0.0799	3.45
V. No. 3	0.7910	0.0889	3.06

Since this paper was written it has come to my knowledge that a similar process has been recommended by Messrs. Drown and Shimer, in a communication to the American Institute of Mining Engineers, and published in the *CHEMICAL NEWS*.

The authors quote results which in the main agree with my own, but they do not supply full details of the mode of operating.

The only difference of note between us is that they do not seem to consider the presence of cinder in pig-iron as fully established. From the results of my own experiments I think there can be very little doubt on this point.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.*

By J. W. MALLET, F.R.S.,
Professor of Chemistry in the University of Virginia.

(Continued from p. 270.)

First Series of Experiments.

Purification of Ammonium Alum.—Ammonium alum of commerce was dissolved in water, a very little nitric acid added, and the liquid boiled in large glass beakers by passing in a current of steam. When the solution had become cold a little ammonium ferrocyanide was added—a very small quantity sufficed to throw down the traces of iron present—and a little animal charcoal, previously well boiled with strong hydrochloric and nitric acid and thoroughly washed, was stirred in to aid in the subsidence of the minute amount of very finely divided Prussian blue which had been formed. The clear liquid was after about ten day drawn off, and evaporated until the larger part of the alum crystallised out on cooling. The crystals, of which there was obtained more than a kilogramme, were re-dissolved in hot water, and re-crystallised several times (throwing away all the mother-liquors), the last time in a porcelain vessel, and with agitation, so as to obtain a granular crystalline powder, which was washed with cold distilled water.

* From the *Philosophical Transactions* of 1880. Paper read before the Royal Society, April 22, 1880.

Re-dissolving in water the so-far purified alum, now much reduced in quality, it became necessary to secure the exclusion of the metals of the fixed alkalies, lest their alums should exist in isomorphous admixture with the pure ammonium alum required. To this end aluminum hydrate was thrown down from the solution by addition of ammonia, using not quite enough of the reagent for complete precipitation. The precipitate was well washed with abundance of water, this tedious process being much expedited by the use of a syphon-filter delivering the liquid drawn off into a large flask connected with a powerful aspirator. The bulk of the precipitate was twice re-dissolved in pure hydrochloric acid (each time avoiding complete solution), thrown down again by ammonia, and again washed.

This hydrate was now dissolved in just the necessary amount of dilute and very carefully purified sulphuric acid, and just the proper amount added of ammonium sulphate prepared from the same sulphuric acid neutralised with ammonia. The quantities were determined by bringing the two solutions to known bulks, ascertaining by experiment on a sample of each how much of the respective salts was present, and measuring off the required volumes to be mixed. After concentrating the mixed solution by evaporation it was allowed to crystallise by cooling, and the crystallisation was repeated thrice, each time washing with a little cold water. On the last crystallisation pains were taken to regulate the rate of cooling so that as far as possible uniformly small crystalline grains were formed of about a millimetre in diameter, thus avoiding the liability of large crystals to contain cavities, in which mother-liquor might be retained, and on the other hand securing the possibility of seeing with a lens, better than could have been done if the alum were in a still finer crystalline powder, that all the crystals as afterwards used were clear and transparent, and showed no signs of efflorescence.

It should be added that all the aqueous ammonia used as above for the precipitation of aluminum hydrate, and for its re-conversion into alum, was recently and carefully prepared from ammonium chloride purified from alcoholic amines by boiling with nitric acid as recommended by Stas,* that the last crystallisations were effected from water which had been, in pursuance of the practice of the same chemist, distilled from potassium permanganate and hydrate, and that for these last crystallisations a large platinum dish was used, and care was taken that the solution was not allowed to boil, nor even to remain for any length of time near the boiling-point, since I ascertained that ammonium alum, like simple ammonium sulphate, gradually gives off small quantities of ammonia on continued boiling of a strong solution. The very last crystallisation was carried out with only a sufficient quantity of the alum for a couple of the final experiments.

The salt thus purified was found to be free from any

* Quoted in *Fresenius's Zeitschrift für Analyt. Chemie*, 1880, 4tes Heft., S. 423.

ascertainable content of foreign substances. It gave no trace of colouration in its solution when tested by a ferrocyanide, tannic acid, &c., and by sulphuretted hydrogen and ammonium sulphide; and spectroscopic examination showed that the fixed alkaline metals and calcium were absent. Silver nitrate gave no indication of chlorine.

Ignition of Ammonium Alum.—*Difficulties Connected with this Method.*—I proposed to ignite a weighed quantity of this alum, whose distinct crystallisation gives it the advantage as to definiteness in the amount of water over the simple sulphate used by Berzelius, and to determine the weight of the aluminum oxide left behind, but careful examination of this process showed that two difficulties were to be feared.

In the first place, having rapidly dried the product of the last crystallisation by gentle pressure between folds of smooth filtering paper* free from loose fibre, portions were weighed off and exposed to the air at about 22° C., with the hope that before long a constant "air-dried" weight would be obtained. It had been previously ascertained that exposure over sulphuric acid led to large loss of water of crystallisation within a short time. It was found, however, that even in the air loss of weight went on for so long a time that it could not possibly be referred to mechanically adherent water only. It is true that this loss fell off very rapidly after the first hour or so, but it was impossible to decide precisely when it began to affect the water of crystallisation. In order to fully exhibit this I quote the following results obtained from a single large specimen kept very long on hand in a place carefully guarded against dust.

				Grms.
Original weight of alum after one hour's exposure to the air at 22.5° C.	..	..	..	35.7456
Loss of weight in 1st twenty-four hours	..	..	..	0.0088
" " 2nd " "	..	..	..	0.0025
" " 3rd " "	..	..	..	0.0017
" " 4th " "	..	..	..	0.0015
" " 5th " "	..	..	..	0.0010
" " 6th " "	..	..	..	0.0012
" " 7th " "	..	..	..	0.0009
" " 8th " "	..	..	..	0.0011
" " 9th " "	..	..	..	0.0007
" " 10th " "	..	..	..	0.0005

This series of weighings was carried on at longer intervals for six months more; the *monthly* loss was at first 0.0087 gm., gradually fell off, became as small as 0.0006 gm. in one month of cold weather when the temperature of the room was unusually low, and again rose, with warmer weather, to 0.0012 gm. for the sixth and last month for which the weighings were continued. It was further found that, on placing some of the small crystals of the alum in a glass vessel deep enough to prevent mechanical loss, sensible loss of weight could be produced by the heat developed in simply crushing and pulverising the salt with a thick square-ended glass rod used as a pestle, and weighed along with the glass and its contents. While, therefore, it might be assumed as probable that mechanically adherent water would be got rid of within a time during which but a very minute quantity of water of crystallisation would be lost, a slight doubt is thrown over the exact formula of the salt as analysed, in reference to this component. Some of the ignition experiments were made with specimens which had been dried by longer exposure to the air than others, as will be noted hereafter.

In the second place it appeared that a minute trace of basic sulphate was retained by the alumina left after ignition at even a very high temperature. This could not be extracted by water, but was detectable by fusion with sodium carbonate free from sulphur, taking care to use an alcohol flame only. By moistening the alumina with a strong solution of pure ammonium carbonate, re-igniting,

and repeating this treatment a second time, it seemed to be possible to remove this source of error, as out of several specimens thus treated only one afforded a barely detectable trace of sulphate.

Details of Method Adopted.—The actual experiments on the ignition of the alum were carried out as follows. To render uniform the amount of atmospheric condensation on the surface of the vessel weighed, a very light glass bottle was specially made, with a delicately blown stopper, the latter carefully ground in and fitting quite air-tight; the bottle of a size to contain the platinum crucible in which the ignition was to be effected. The crucible was heated to bright redness, and while still quite hot was placed in a desiccator at some distance above a surface of recently distilled sulphuric acid. When cooled down to the temperature of the balance-room the crucible was as quickly as possible transferred to the weighing bottle, which was at once closed, and the combined weight of bottle and crucible was taken. The stopper was then removed for an instant, the cover of the crucible raised, and the quantity of alum desired, which had been roughly weighed off in a tube, having been poured in, occupying in no instance more than one-third depth of the vessel, cover and stopper were replaced, and a second weighing gave, by the gain upon the first, the exact amount of alum used. Attached to the inner side of this crucible cover was a piece of rather stout platinum wire, which, when the cover was in place, ran down into the crucible in the line of its axis of figure, carrying two little diaphragms of platinum foil perforated with small holes (see fig. 1); such a diaphragm

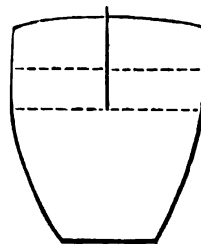


FIG. 1

having been suggested and used by Dumas* in his researches on atomic weights as the means of preventing any loss of solid particles which might otherwise be carried off mechanically from the substance ignited. To avoid inconvenience from the fusion of the alum in its water of crystallisation, and the swelling up of the salt to a bulky, porous mass, the heating was conducted very gradually. The platinum crucible was kept for an hour at 90° C., then for an hour at 100°, for an hour at 110°, another hour at 120°, a like time at 140°, and was then gradually brought to ignition over an argand alcohol lamp. It was then placed inside a larger platinum crucible, resting on a flat bit of unglazed porcelain at the bottom of the latter, and exposed to a gradually increased, and at last bright yellow heat in a gas furnace of Fletcher's construction. This temperature was maintained for a full hour. On cooling down, the smaller crucible was taken out, the cover cautiously raised, and enough of a strong solution of ammonium carbonate introduced to moisten the alumina. Drying gently in a steam-bath, the crucible was re-ignited over an alcohol blast lamp, producing a strong red heat, and the addition of ammonium carbonate, drying, and ignition once repeated. As soon now as the crucible had ceased to be visibly red-hot it was placed in the desiccator as at first, allowed to cool down to the temperature of the balance-room, quickly transferred to the weighing bottle, the stopper of which was inserted, and the final weighing was made while the alumina in the crucible was thus protected from absorption of moisture from the air. These experiments were carried out during a period of remarkably

* This had been previously purified by ample washing with acid and water, and well dried.

* *Annales de Chimie et de Physique*, loc. cit.

steady weather, with very little variation of atmospheric temperature, pressure, or moisture in the balance-room during the whole series.

Direct Results of First Series of Experiments.—The results were as follows:

A.—Alum dried by exposure to air for 2 hours at 21°—25°C.

(NH ₄) ₂ Al ₂ (SO ₄) ₆ .24H ₂ O.	Al ₂ O ₃ .
I.—8.2144 grms. left	0.9258 grm.
II.—14.0378 " "	1.5825 grms.
III.—5.6201 " "	0.6337 grm.
IV.—11.2227 " "	1.2657 grms.
V.—10.8435 " "	1.2216 "

B.—Alum dried by exposure to air for 24 hours at 19° to 26° C.

VI.—12.1023 grms. left	1.3660 grms.
VII.—10.4544 " "	1.1796 "
VIII.—6.7962 " "	0.7670 grm.
IX.—8.5631 " "	0.9654 "
X.—4.8992 " "	0.5528 "

(To be continued.)

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING MAY 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington; and late Deputy Medical Officer of Health for the City of London.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

June 5th, 1882.

SIR,—In the following tables you will find recorded the results of our analyses of the 180 samples of water collected by us during the month of May, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 180 samples, one was recorded as "slightly turbid" and two as "very slightly turbid." The remaining 177 samples were bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from May 1st to May 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole, excepting one which was "slightly turbid," were found to be well filtered, clear, and bright.

Of the 24 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole, excepting one which was re-

corded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole, excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

During the past month the condition of the waters, as regards colour, has been unexceptionable. With respect to their freedom from turbidity, never, with one exception, since we commenced our examinations a year and a-half ago, have the waters approximated so nearly to a state of perfect filtration as they have during the past month. They have, moreover, presented their usual excellent condition of aëration.

The proportion of organic matter, as deduced alike from the results of the Oxygen and the Combustion processes, was, especially during the earlier part of the month, in excess of the very low proportions to which we directed attention in our preceding Reports. The amount of excess, however, was not important or calculated to affect the character of the water in respect to wholesomeness and suitability for domestic purposes.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

NUMERICAL RESULTS FOR THE MEAN RATIO OF OXYGEN TO THE SUM OF OXYGEN AND NITROGEN IN ATMOSPHERIC AIR.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

SINCE the proportion of oxygen to nitrogen in the air varies almost as incessantly as its temperature or pressure, the mean value can be accurately ascertained only by regular and continuous observation. The true value cannot be safely inferred from observations at irregular intervals.

A series of daily analyses in duplicate, continued for six months, undertaken for a very different purpose, may therefore be of some interest as contributing to the knowledge of this constant.

The result is affected with errors depending on the following causes, the probable magnitude of which is well known.

1. The most serious uncertainty depends on the uncertainty of the calibration of the eudiometer. The probable error of a single determination at any given point on the scale is three milligrammes of water. At each point four determinations were made, so that it is as likely as not that the volume at any given point is known within a milligramme and a half of water. The probable error of the mean result, as far as this error depends on errors of calibration, is 0.0014 per centum.

2. The second source of uncertainty depends on the fact that the composition of the air is variable. Owing to this variation, the result of the number of samples analysed is as likely as not to differ from the result from an unlimited number of samples by 0.0009 per centum.

3. The third source of uncertainty depends on the accidental errors of analysis. Owing to these errors, the

* *Proceedings of the American Association for the Advancement of Science*, vol. xxix., Boston Meeting.

mean result obtained from two analyses of each sample is as likely as not to differ from what would have been obtained by an unlimited number of duplicate analyses of each sample by 0.0002 per centum.

This result is also affected with one source of constant error which has not yet been taken into account. This error is due to the fact that the audiometer tube, after the explosion, contains a larger volume of water than at the previous measurement. I do not see clearly how to determine the magnitude of this error.

It is at present hoped that other sources of error produce only results which may safely be neglected in comparison with these.

The mean composition of the air, and the magnitude of the errors attending the determination, may then be stated as follows:—

Ratio of oxygen to sum of oxygen and nitrogen,	20.949	per ct.
Probable error from imperfect calibration, 0.0014	0.0014	.. ..
Probable error from variation in ratio, .. 0.0009	0.0009	.. ..
Probable error from accidental errors, .. 0.0002	0.0002	.. ..
Total probable error,	0.0016	.. ..

SOME CONCLUSIONS AS TO THE CAUSE OF THE FREQUENT FLUCTUATIONS IN THE RATIO OF OXYGEN TO NITROGEN IN THE AIR AT DIFFERENT TIMES.*

By EDWARD W. MORLEY, of Hudson, Ohio.

(ABSTRACT.)

To study the subject above indicated, I have made duplicate analyses of air collected at Hudson, Ohio, on every day from January 1st to June 30th, 1880. The results have been graphically compared with the daily observations on temperature and pressure of the atmosphere made by the Signal Service at Cleveland, Ohio, from which Hudson is not far distant. Many of the variations in the amount of oxygen observed are closely connected with variations in the temperature and pressure. For the prediction or explanation of these, local observations of temperature and pressure might be sufficient.

I have also been favoured, through the courtesy of General Myer, with the thrice-daily maps of the state of the weather for the period mentioned. From a comparison between these maps and the results of my analyses, I derive some interesting conclusions, serving to confirm the notion that most of the variations in the amount of oxygen are caused by the vertical descent of air from above. I find this notion strikingly confirmed in some cases where it was some time since evident to me that Loomis's suggestion that the cold was caused by the descent could not be accepted as holding good. I find evidence that some depressions of temperature are caused by such descent, and at such times the amount of oxygen falls promptly at the beginning of the cold. But with the times of depression of temperature remarkable for their suddenness and severity, a vertical descent of cold air seems to be the effect and not the cause. The descent follows the cold by a day or two or more, and at the time when the Signal Service maps lead me to suppose the descent has begun, and not till then, the fall in oxygen occurs.

The variations found this year have not been as great as those published by me last year, nor as great as those found by Jolly. I have therefore carefully re-examined those made before this year, and am confirmed in my confidence that they are affected with no unsuspected error.

* *Proceedings of the American Association for the Advancement of Science*, vol. xxi., Boston Meeting.

ON THE DETERMINATION OF PHOSPHORUS IN IRON AND STEEL.

By E. AGTHE.

THOUGH very numerous methods have been proposed for this determination the only one generally used is the old process with molybdic acid, followed by precipitation with magnesium mixture. The author finds that the precipitation with molybdic acid is the delicate point of the process, and that the following precautions conduce to the greatest accuracy. The authors who have occupied themselves with the question give conflicting instructions as to the time necessary for the complete precipitation of the phospho-molybdate. Classen speaks of four to six hours; Fresenius and Ledebur (*Guide pour l'Analyse Metallurgique*, 1880), indicates twelve hours. The author has found that on operating as laid down below four hours are amply sufficient, and that a more prolonged contact is often the cause of defective results. If the analyst is pressed for time he may even filter after one hour.

Five grammes of the sample are dissolved, 50 c.c. of the molybdic liquid are added, the mixture is stirred frequently and filtered after four hours.

In these conditions the determination is exact when the proportion of phosphorus does not exceed 11 to 15 (? 0.11 to 0.15) per cent. Beyond this range the result becomes uncertain. For a proportion of 43 (? 0.43) per cent., 50 c.c. of the molybdic solution are required, as this reagent must always be in excess. In place of 50 c.c. 75 or 100 c.c. of the molybdic solution are employed which is still suitable for proportions of phosphorus of 7 and even 8 (? 0.7 and 0.8) per cent. If the percentage is still higher, only 2 grms. or 1 gm. of the sample should be dissolved. The nitric acid should not be too concentrated or employed in excess, as it hinders complete precipitation. As far as possible the carbon should be burnt off, as the presence of this element renders the result too low.

If in the analysis of steel, white pig-iron or manganese iron—in short iron low in silica,—this body is not separated, the result is too high. It is necessary therefore to filter before adding the molybdic acid even in cases where no distinct precipitate of silica can be seen.

Before filtration the solution should be let take the ordinary temperature of 15° to 20°, otherwise the filtrate will become turbid and deposit a slight precipitate. The author operates as follows:—He dissolves 5, 2, or 1 gm. of the sample, according to its supposed richness, in 50 c.c. of nitric acid; he then evaporates to dryness and heats rather strongly, and to eliminate the last traces of nitric acid he evaporates a second time with hydrochloric acid. The residue treated with concentrated hydrochloric acid is taken up in water, and the silica which remains insoluble is separated by filtration. The liquid is evaporated again over a naked flame in a porcelain capsule as long as the ferric chloride which is deposited on the sides of the vessel re-dissolves on inclining the capsule, and the process is then continued on the water-bath to incipient solidification. This operation requires to be watched, for if there remains too much hydrochloric acid the results are too low; if, on the contrary, too much acid is driven off and hard crusts are formed, we do not obtain a clear solution with nitric acid.

After cooling, we add 35 c.c. of ammonia (0.96) and mix with the stirrer, so as to obtain a homogeneous paste, and add 75 c.c. nitric acid (1.12 to 1.20) and the whole is set on the water-bath. When the solution is complete the liquid is transferred into a precipitating glass and from 50 to 180 c.c. of the molybdic solution are added and the whole is kept at a temperature of 50 to 80°, stirring frequently. After four hours it is let cool, filtered, and washed with dilute molybdic liquid. The author recommends the following proportions for the preparation of the molybdic solution:—115 grms. of molybdic acid are dissolved in 460 grms. ammonia (0.96) and made up with

water to 1 litre. This solution is then poured into 1 litre nitric acid at sp. gr. 1.20, and the mixture is let stand for a day and filtered.

When the phospho-molybdic precipitate has been sufficiently washed it is dissolved in the smallest possible quantity of ammonia; the ammoniacal solution is neutralised with hydrochloric acid up to the point where the precipitate produced by this reagent is re-dissolved very slowly, and when cold it is mixed with 15 to 25 c.c. of magnesia-mixture, stirred well and filtered after standing for six hours. The precipitate is washed with ammoniacal water, dried, calcined, and weighed.

The author prepares his magnesia-mixture as follows:—

Magnesium chloride	..	..	..	101.5
Ammonium chloride	..	..	..	200
Ammonia (sp. gr. 0.96)	..	..	..	400
Water	..	..	..	1000

It is well to ascertain that the mother-liquors from the ammonium phospho-molybdate when mixed with ammonia slightly heated does not give a further precipitate; in the contrary case the analysis would be inaccurate. It may, however, be completed by neutralising as far as possible with ammonia, adding molybdic liquid, and adding the second precipitate to the former.—*Moniteur Scientifique*.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, June 24th, 1882.

Prof. CLIFTON, President, in the Chair.

NEW members—Professor Bartholemew Price, Principal Viriamu Jones.

Prof. G. CAREY FOSTER moved a vote of thanks to Prof. Clifton for the excellent reception accorded to the Physical Society at Oxford on the preceding Saturday, and drew attention to the high efficiency of the Clarendon Laboratory and the admirable provision made for the teaching of physics at Oxford.

Prof. W. G. ADAMS seconded the motion, and endorsed Prof. Foster's views of the position of physical science on the Isis.

Prof. CLIFTON, in response to the vote, stated that the University of Oxford had liberally supported him in organising the Clarendon Laboratory, giving him all the funds he required, and showing a laudable desire to put physical teaching on the best possible footing in Oxford.

Professor C. A. BJERKNES, of Christiania, was then introduced to the meeting, and, assisted by his son, M. Vilhelm Bjerknes, delivered a lecture on "*Hydrodynamic Analogies to the Phenomena of Electricity and Magnetism*," which was illustrated by experiments and projections on the screen. Prof. Bjerknes has been engaged in tracing these analogies for the last twenty-five years: at first mathematically, but latterly by experiments in verification of the deductions from his formulae. These experiments were shown in the Paris Electrical Exhibition last year, and have been published repeatedly in this country. Prof. Bjerknes has, however, advanced beyond the results there shown. These were chiefly confined to illustrating the static attraction and repulsions of electricity and magnetism; but he has now taken up the subject of electrodynamic attractions and repulsions. The former effects are shown by brass balls oscillating, or by small tambours pulsating, near each other in water. These motions are communicated to the balls and drums by pulses of air, transmitted from an ingenious air-pump or bellows along india-rubber tubes. A pulsating drum corresponds to a magnetic pole: an

oscillating body to a magnet. When two tambours are vibrating near each other in like phase they attract; when in unlike phase, they repel each other. The same holds true of the oscillating balls. The motion lines round these bodies correspond to the lines of force round magnets, as was demonstrated by a hollow ball oscillating on a stem, and tracing its movements in ink on a glass plate. All the phenomena of magnetic forces were illustrated in this way by Prof. Bjerknes, including diamagnetism, which was shown by means of pith cylinders lighter than the water or medium of oscillation. A pulsating drum or oscillating ball repelled the cylinder of pith, whereas it attracted a cylinder of wax, which is heavier than the water. The more novel part of the experiments consisted in representing the attraction between two electric currents flowing in the same direction, by means of two cylinders, about 5 inches long and 1 inch in diameter, oscillating round their longitudinal axes at close quarters in the water. The cylinders were oscillated by means of a pulsating tambour, which communicated its motion to them by a toothed gearing on their ends. Attraction resulted when the oscillations of the cylinders were in the same phase, and repulsion when they were in opposite phase. This is an inversion of what might have been expected to take place after the theory of Ampère. A square of four oscillating cylinders was also formed, and a fifth cylinder oscillated inside it, the attraction or repulsion exerted on the latter being observed. A hydrodynamic galvanometer was made by placing an oscillating ball (which corresponds to a magnet) beside an oscillating cylinder, the result being a deflection of the ball according to the direction of the oscillation of the cylinder. The experiments were witnessed by a full meeting, which accorded a hearty vote of thanks to Prof. Bjerknes.

A paper by Dr. C. R. ALDER WRIGHT, F.R.S., was taken as read. It was on "*The Determination of Chemical Affinity in Terms of Electromotive Force*" (Part VI.), and on the relations between the E.M.F. in cells constructed like Daniell's cell, but containing different metals, and the chemical affinities involved in their actions. The cells employed were constructed of cadmium and copper and their sulphates, zinc and cadmium and their sulphates, zinc and silver and their sulphates, cadmium and silver and their sulphates, copper and silver and their sulphates. In all cases the sulphate solutions were of equal molecular strengths. The general result is that the effect of a given alteration in the character of the plates opposed to cadmium or silver was found to be practically identical with that of the same alteration in the case of a Daniell cell. Volta's law of the summation of electromotive forces sensibly holds true in the cases examined. These cells also behave like a Daniell under variations of current density.

The Society meets again in November.

NOTICES OF BOOKS.

Coal. Spontaneous Combustion and Explosives occurring in Coal Cargoes: their Treatment and Prevention. Also the Prevention of Fire or Explosions in Ships from Cargoes or Stores containing Substances of a Volatile and Inflammable Nature. By THOMAS ROWAN. London and New York: E. and F. N. Spon.

THE public has long been aware of the dangers which arise in coal mining from the emission of gas, highly combustible, and when mixed with atmospheric oxygen, explosive. But it has only of late become generally known that the danger does not cease when the coal is raised to the surface, but continues to exist when it is taken on board ship, either as an article of commerce or for working the engines of steamers. Coal is in fact rightly described by the author as a "most dangerous and treacherous

cargo." Not a few attempts have been made to combat the evil, and in 1875 a Royal Commission was duly appointed to investigate the subject. But so little practical benefit has resulted from the investigations undertaken and the recommendations issued that at Liverpool the premiums for underwriting coal cargoes have lately risen 5s. to 10s. per cent.

Spontaneous combustion, commonly so-called, in coal may arise from two causes. On the one hand is the oxidation of the iron sulphide, iron-pyrites, known to coal miners as "brasses" or brass lumps, which are never entirely absent in coal. This sulphide varies much in its physical conditions and in its consequent stability. Some varieties, if they come in contact with the air, rapidly absorb oxygen, and evolve considerable heat, as is perhaps most strikingly exemplified in the Campsie mines, near Lennox Town.

But the oxidation of sulphur present as iron sulphide is neither the only, nor, in the opinion of some authorities, the most effectual, agency in the ignition of masses of coal. The coal itself can absorb oxygen just as is done by shoddy, cotton-waste, weighted silks, &c., and can thus become heated to the ignition point. This view, put forward by Dr. Percy as far back as 1864, has been since experimentally demonstrated by Prof. Richters, who shows that the liability of coal to self-inflammability bears no relation whatever to the percentage of sulphur actually present. We must here, however, submit that a not unimportant element has been left out of consideration in the tabulated results of Prof. Richters, and that is the relative stability of the iron sulphide in different kinds of coal. There are kinds so dense that they are carefully rejected by the copperas manufacturers, who find that they may be exposed to air and moisture for a year or upwards without becoming appreciably oxidised, whilst others quickly swell up, crumble, and liberate heat. It is hence, we submit, evident that from the total percentage of the sulphur in a coal, taken without regard to its condition, no conclusion can be drawn as to its tendency to bring about ignition. The author doubts, indeed, whether the conditions in the experiments of Richter are the same as those which exist in a cargo of coal or in the bunkers of a steamer. He contends that the facts disclosed in the Report of the Royal Commission show that "in the majority of cases, chemical action has been first set up by the oxidation of the iron pyrites in the coal." Thus the liability to spontaneous combustion increases *pari passu* with the tonnage of the cargoes, which is precisely what we should expect if the ignition is determined by the oxidation of pyrites. Thus in cargoes below 500 tons the casualties were under $\frac{1}{4}$ per cent; in cargoes from 500 to 1000 tons the proportion was 1 per cent; between 1000 and 1500, it reached $3\frac{1}{4}$ per cent, whilst with cargoes of over 2000 tons the proportion of casualties reached 9 per cent. This increase is the most striking in the case of long voyages. Out of five ships with cargoes of over 2000 tons sent in 1874 to San Francisco two suffered.

It further appears that in the majority of cases dealt with in the Report the coal had been shipped in a damp state. It was stated before the Commission that one and the same kind of coal, taken from the same working, if protected from the rain remained cool, whilst another portion of the same lot, which had been left uncovered and become wet, set up spontaneous combustion. Now moisture, whilst favouring the oxidation of pyrites, is, in the author's opinion, likely to prevent the oxidation of the carbon by filling its pores. Hence, he argues that in the majority of cases the ignition has been primarily determined by the oxidation of the pyrites, the heat thus liberated inducing, probably, carbonaceous oxidation also. When once a certain temperature has been reached, gaseous and volatile products of the destructive distillation of coal naturally appear, and may sometimes cause the cargo to burst into flame. But such products can of course never be the original cause of the rise of the temperature.

Mr. Rowan next criticises a work written in 1878 by Mr. J. W. Thomas, F.C.S., entitled "A Treatise on Coal, Mine-gases, and Ventilation." Some of the passages here quoted are very remarkable, e.g., the assertion that pyritiferous coals are rarely shipped.

One of the chief conclusions of the Royal Commissioners—which the author describes as of a very negative character—is that the breakage of coal in its transport from the pit to the ship's hold, the shipment of pyritic coal in a wet condition, and especially ventilation through the body of coal cargoes—which Mr. Thomas recommends—conduce to spontaneous combustion. A system of surface ventilation for the escape of explosive gases in all weathers is proposed.

Mr. Rowan's own proposals are, first a system of "abstractors" scattered through the coal-holds at different levels, and capable of being brought into action as occasion arises, and as determined by means of thermometers placed in the indicators themselves. When coal is destined for a long voyage, or when it is known to be of a dangerous nature, he suggests that it should be brought from the pit in shallow iron waggons with perforated sides and bottoms. These waggons prior to shipment should be run into stove-houses and submitted to a temperature of 150° F. for a length of time varying from one to eight days, and should then be allowed to cool, protected from the weather.

In this manner carbonaceous oxidation would be anticipated, so that any further danger from this source on board ship would be excluded. Any fire-damp existing in the pores of the coal would be driven off, and the removal of moisture would render pyritic oxidation less likely. As regards the efficacy of this plan we feel little doubt, but we fear that the erection and management of these stove-houses would prove in practice too costly. It would require a large building to receive 2000 tons of coal in shallow waggons.

An important fact is here mentioned, that no cases of spontaneous combustion have occurred with cargoes of patent fuels.

Space does not allow us to discuss the authors' remarks on explosives arising from such bodies as "xerotine siccative." Mr. Rowan's work must be pronounced a timely publication, and deserves the attention of all persons directly or indirectly connected with the exportation of coal.

Proceedings of the American Pharmaceutical Association at the Twenty-ninth Annual Meeting, held in Kansas City, August, 1881. Philadelphia: Sherman and Co.

THE first portion of the "Report on the Progress of Pharmacy" contains a notice of several recent kinds of apparatus, such as the balances of Westphal, of Bunge, and Ruprecht, Pellet's burette, Gantler's extraction apparatus, Weigelt's displacement apparatus, Mollin's rapid filter, Terquem's gas-burner, &c. In an extract on soaps it is stated that the so-called rock potash or ball potash sold in the United States without exception not only is not potash, but is composed exclusively of soda, and is consequently useless for the manufacture of soft soaps.

It appears, according to Limousin, that in preparing oxygen from chlorate of potash without the presence of manganese peroxide explosions are possible. In the latter part of the process potassium perchlorate is formed, and particles of this, carried over in to the vulcanised tubes (if such are used), may become ignited and produce hydrocarbons, which form an explosive mixture with the oxygen.

According to Mr. R. F. Fairthorne, muddy water may be purified by adding to it "phosphate of lime"—whether soluble or insoluble does not appear—in the proportion of 1 oz. to 1 quart, and allowing it to settle. In a few days (!) it may be filtered. This process seems too expensive and too tedious for practical purposes.

We regret to see the increasing tendency, e.g., in Arkansas, to lay restrictions upon the sale of important chemicals under the pretext that they are poisonous. So long as explosives are freely sold to all comers, to enact regulations concerning the sale of poisons is indeed to "strain at a gnat and swallow a camel." To add to the farcical character of these enactments, quack medicines are in some cases especially excepted from their operation.

We are glad to perceive that the "Food and Drug Adulteration Act" of Michigan, prohibits the addition of glucose or starch sugar to articles of human food, and that of oleomargarine, suine, &c., to butter and cheese, without stating distinctly on the label the proportion of the addition. A similar enactment in England would open the eyes of the public to the true nature of the mixture mendaciously sold as "coffee as in France." Prof. P. W. Bedford states that all the commercial varieties of sodium phosphate examined contained sodium sulphate ranging from 19.5 to 57.5 per cent.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 4.

Trustworthiness of Experiments on Heating.—A. Wagner.—A continuation of the author's researches on the trustworthiness of analyses of the gaseous products of combustion, being a reply to Dr. Bunte (*Zeitschrift Anal. Chemie*, xx., 163).

Behaviour of Manganese Ore and Chloride of Lime on Ignition with Chromic Oxide and Sodium Carbonate in the Absence of Air.—A. Wagner.—Already noticed.

Sulphur in Zinc Powder.—A. Wagner.—Two samples of zinc powder were found to contain respectively 0.12 and 0.011 per cent of sulphur. A sample of red zinc sold as chemically pure contained 0.004 per cent of sulphur.

Bismuth Oxide as a means of rendering Silicates Soluble.—W. Hempel.—Already noticed.

Metallic Copper as an Absorbent for Oxygen Gas.—W. Hempel.—The author has for some time been engaged with experiments on the use of metals at common temperatures as absorbents for oxygen in presence of ammoniacal vapours. This absorption proceeds with rapidity as long as bright metallic surfaces are exposed to a gaseous mixture containing oxygen, but ceases or becomes very slow as soon as appreciable quantities of oxide are formed. He has therefore examined if it is possible to effect complete absorption by using ammonium carbonate as a solvent for the oxides formed. Experiments proved that oxygen was quickly and completely absorbed in contact with copper and a solution of commercial ammonium carbonate, but that appreciable quantities of carbonic acid were evolved. Complete absorption of oxygen without the development of any gas was effected if it was exposed to metallic copper and a solution consisting of equal parts of a saturated solution of commercial ammonium sesquicarbonate, and a dilute solution of ammonia at 0.93. Such a liquid has a tension which may in most cases be disregarded, and if the apparatus contains sufficient quantities of metallic copper it is able to take up 24 vols. of oxygen.

An Apparatus for Fractional Distillation.—W. Hempel.—This paper cannot be reproduced without the accompanying illustration.

Analysis of Crude Zinc.—O. Günther.—This memoir will be inserted at length.

A New Method for the Volumetric Determination of Molybdenum.—F. Mauri and L. Danesi.—The determination of molybdic acid succeeds very well if potassium iodide is used proportionally to the molybdic acid which may be present, and in such a proportion that rather more than 2 mols. of potassium iodide are used to 1 mol. of molybdic acid. A moderate excess does not interfere with the final result. The reaction takes place perfectly at common temperatures when the molybdate, dissolved in hydrochloric acid, is digested for some hours with the potassium iodide.

Determination of Nicotine.—R. Kissling.—The author calls attention to the inaccuracies in Skälweit's recent memoir on the quantitative determination of nicotine in tobacco (*Repertorium der Analyt. Chemie*, vol. i., No. 11, p. 165).

A Simplification of Gliniski's Platinum Wire Net in Fractional Distillation.—A. Belohoubek.—This paper requires the accompanying illustration.

A Convenient Process for obtaining Metallic Zinc in Forms suited for Analytical Uses.—C. Mann.—The author melts the zinc at a low temperature over the gas flame in a porcelain crucible or in a muffle furnace in earthen crucibles, in each of which some borax ought to be previously melted so as to glaze the inner surface. The melted metal is poured in small quantities upon a polished flag-stone inclined at an angle of 25° to 30°. In this manner the metal is obtained in bands half a litre in length and 0.2 to 0.5 m.m. in breadth. They are perfectly free from oxide, very brittle, and crystalline in texture.

Process for Manipulating with Sulphuretted Hydrogen.—G. S. de Capanema.—This memoir is unintelligible without the accompanying illustration.

Trustworthiness of Experiments on Heating.—H. Bunte.—A reply to A. Wagner's memoir contained in the present issue.

Correct Performance and the Sensitiveness of the Method of Fresenius and Babo for the Detection of Arsenic.—W. Fresenius.—This paper will be inserted at length.

A Micro-prismatic Method for Distinguishing Solids.—O. Maschke.—The author makes use of the circumstance that particles of a transparent substance, if surrounded by a liquid which possesses a higher refraction index than the solid in question, display under the microscope very characteristic colours, the intensity of which increases with the difference of the refraction-indices. If particles of a substance, however minute, are by degrees enveloped in liquids of different refraction-indices, it is easy to find a liquid which produces the faintest intimation of these colours, and has consequently almost exactly the same refraction-index as the body itself. If this is then determined for the liquid it is known for the body in question. The author uses as liquids, water, amyl alcohol, glycerin, oil of almonds, and oil of cassia. All bodies are of course excluded from this method which are opaque, or possess a refraction-index higher than oil of cassia (1.606), or are attacked by the liquids.

Nitrite Solution of Potassium Iodide and Starch Mixture.—A. Vogel.—The author has examined this mixture as regards its behaviour with acid liquids. He used a very dilute potassium iodide starch paste, to which he added so much potassium nitrite that the liquid was coloured deeply blue by a few drops of acetic acid. It was coloured a deep blue by dropping in moderately dilute solutions of most inorganic and organic acids and acid salts, whilst weak and sparingly soluble acids, such as the carbonic, boracic, arsenious, uric, carbolic, tannic, had no action.

The Behaviour of Ferrous Sulphate on Keeping.—E. Johanson.—Ferrous sulphate becomes oxidised the more readily the more completely the external air is excluded. To explain this phenomenon he suggests that

the ferrous sulphate has an ozonising action upon the oxygen of the inclosed air, which then reacts the more strongly upon the ferrous sulphate the less it is diluted by the external air.

Preservation of Standard Solutions of Stannous Chloride.—Sorge recommends that these liquids should be kept in a bottle tubulated at the bottom, so that the solution is drawn off below, whilst coal-gas is allowed to enter above to fill up the vacancy.

A Coloured Reaction of Atropine and Daturine.—D. Vitali.—If a specimen of either of these alkaloids or of their salts is covered with a little fuming nitric acid, let dry up on the water-bath, and when cold moistened with a drop of potassa dissolved in absolute alcohol, a violet colour is instantly produced, and soon passes into a fine red. Only the violet colour is characteristic, as strychnine also gives a beautiful red colour if similarly treated. According to the author, 0.000001 grm. of atropine sulphate can thus be detected. None of the other important alkaloids give a similar reaction.

Action of Copper Hydroxide upon Certain Kinds of Sugar.—J. Habermann and M. Hönig.—The pure hydroxide, if boiled with aqueous solutions of levulose, dextrose, inverted sugar, and cane-sugar, is reduced to cuprous oxide. With levulose, dextrose, and inverted sugar the reaction begins at once with ebullition, and goes on rapidly with levulose and inverted sugar, but more slowly with dextrose. With cane-sugar the change sets in only after several hours boiling, *i.e.*, probably after the cane-sugar has been inverted. The following oxidation products were observed in all the above-mentioned sugars: Carbonic, formic, and glycolic acids, and an amorphous residue not yet fully examined. If barium hydroxide is allowed to act along with copper hydroxide the same acids are formed, but the process is more rapid. Copper hydroxide acts upon milk-sugar in the same manner, but the decomposition-products have not been further examined.

Oxidation of Caffeine and Theobromine.—R. Maly and F. Hinteregger.—If caffeine is boiled for six hours with chromic acid mixture it is completely oxidised, yielding 40 per cent of cholestrophan or dimethyl-parabanic acid. Theobromine, if similarly treated, gives the homologue of cholestrophan, mono-methyl-parabanic acid.

Determination of Nicotine.—J. Skalweit.—We may return to this memoir on a future occasion.

Determination of Starch and Dry Matter in Potatoes.—M. Märcker.—The author gives tables showing the relation of the proportions of these constituents to the specific gravity.

Determination of Carbonic Oxide in Air.—J. v. Foder.—The author allows moderately diluted blood to remain in contact with the air in question in a 10- to 12-litre bottle, or he passes 10 to 12 litres of the air through the blood, and then shakes it up in a test-tube with ammonium sulphide. Unmodified blood appears violet by transmitted light, whilst that which has absorbed carbonic oxide is coloured red. For the quantitative determination of the carbonic oxide absorbed by blood the latter is put in a small flask, through the doubly perforated stopper of which are passed two tubes. The one, which reaches to the bottom, serves to introduce air washed by a passage through palladium chloride. The other conducts the air issuing from the flask into two washing-bottles, one of which contains a solution of lead acetate, and the other dilute sulphuric acid. From the washing-bottles the air passes into two U-tubes containing palladium chloride. The flask is then set on a water-bath, and the blood kept for a quarter of an hour to half an hour at 90° to 95°. Meanwhile an exceedingly slow current of air is aspirated through the flask, which is frequently shaken. As soon as the colour of the blood begins to change the carbonic oxide hæmoglobine is split up, the carbonic oxide is set free, and a black precipitate

of palladium appears on the surface of the solution of palladium chloride. This is separated, washed, dissolved in *aqua regia*, and the solution is treated with a standard solution of potassium iodide (1.486 grm. KI in 1 litre) till a filtered portion no longer gives any turbidity with a drop of the potassium iodide. In this manner its quantity and consequently the quality of the carbonic oxide can be calculated. Each c.c. of the potassium iodide represents 0.1 c.c. carbonic oxide.

Absorption of Carbonic Oxide by means of Blood.—C. H. Wolff.—In order to preserve such blood for spectroscopic observation the author uses a mixture of equal parts of defibrinated blood and of solution of borax, saturated in the cold. If it is desired to detect carbonic oxide in combustion products the air must first be passed through a washing-bottle with slaked lime, to absorb all acid products which destroy the colouring matter of blood.

Determination of Organic Matter in Air.—Ira Remsen.—The air is passed by means of an aspirator through a tube drawn out at one end, 5 to 7 inches long and 3 to 8 inches in diameter, filled with coarse pumice moistened with water. In ten hours 90 to 100 litres of air are passed through the absorption tube, in which the ammonia and the organic matter are retained. The pumice is then covered with 500 c.c. water in a suitable vessel, and the liquid is treated for free and for albumenoid ammonia, according to the process of Wanklyn, Chapman, and Smith.

Detection of Ammonia and other Impurities in the Atmosphere.—A. H. Smee.—The author fills a glass funnel, drawn out to a point and closed at the bottom, with ice. The dew which condenses from the air on the cold sides of the funnel collects in drops, which run down over the closed point into a capsule. The quantity of water condensed in a given time may be measured, and the ammonia determined colorimetrically. By this cold distillation, it is possible to concentrate bodies which are decomposed at higher temperatures, *e.g.*, the odours of flowers. In the condensed dew may be found the microbia or parts of such thrown off from the body in disease.

Examination of Flour for the Ordinary Impurities and Adulterations.—A. E. Vogl.—The author adds to dilute alcohol at 70 per cent, 1-20th of hydrochloric acid. About 2 grms. of the flour in question are shaken up in a test-tube with 10 c.c. of this liquid, and the colour, both of the solution and of the sediment which gradually collects at the bottom, are observed. In some cases a change of colour is observed at once, but in others it only occurs on standing, and is promoted by heat. Pure flour (wheat or rye) remains white, and the liquid is colourless, showing merely a yellowish tint in coarse qualities. Pure barley and oatmeal give a straw-yellow liquid. Corn cockle colours the liquid a full orange; vetches and beans, a fine purple-red.

Detection of Rhinanthine in Bread.—C. Hartwich.—An alcoholic extract of the bread or flour is boiled with some hydrochloric acid. If rhinanthine is present the liquid on cooling takes an intense green colour.

Speed of Evaporation of Pure Water.—A. Müller.—The author has devised for this purpose an especial hydrostatic balance, which he names the xerometer.

Detection of Alcohol in Essential Oils.—E. Barbier.—The author distils off 1-10th and adds to the distillate an excess of dry potassium acetate, which forms with the alcohol a heavy solution, and can be separated by means of a separation funnel from the supernatant ethereal oil; it is then mixed with 4 vols. of water, and again saturated with potassium acetate, by which means a further quantity of essential oil is separated out.

The Detection of Fusel in Alcohol.—A. Jorissen.—The author adds to 10 c.c. of the sample 10 drops of colourless aniline oil and 2 to 3 drops of officinal hydrochloric acid. If fusel is present a red colour soon appears.

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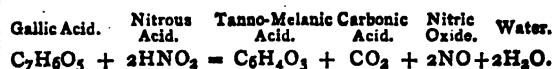
ON A NEW AND EXPEDITIOUS METHOD FOR THE DETERMINATION OF THE NITRITES UNDER DIFFERENT CIRCUMSTANCES.*

By EDMUND W. DAVY, A.M., M.D., M.R.I.A.,
Professor of Forensic Medicine, Royal College of Surgeons, Ireland.

As the existence of nitrites and nitrates in different natural waters has been regarded (under certain circumstances) as affording evidence of previous sewage contamination, the determination of the presence or absence of such compounds, and their quantitative estimation when present; in the waters employed for domestic purposes, may be a matter of much importance in a hygienic point of view; and though we have some delicate tests for the detection in such of the presence both of nitrites and nitrates, as well as different methods for their conjoint quantitative determination, there is no very simple or expeditious method for the separate estimation of nitrites in waters, which may sometimes be required, if we except that not long since proposed by P. Griess, which method I shall presently describe, and compare with the one I have myself devised, and which I shall now lay before the Academy.

In making lately some experiments on certain nitrites, I observed a reaction, which, as far as I am aware, has not hitherto been described; and this being one of extreme delicacy, I have founded on it a new method not only for the detection of the presence, but likewise for the quantitative determination of the nitrites under different circumstances, but especially in the case of natural waters, for which it is peculiarly suitable. The reaction referred to is that of nitrous acid, or of a soluble nitrite, on the well-known substance, gallic acid; thus when an aqueous solution of that latter acid is brought in contact with a soluble nitrite, the mixture, unless the amount of the latter present be very small, will soon acquire a yellow or yellowish-brown tint, which will increase in depth up to a certain point, after which the colour remains permanent, whilst, at the same time, minute globules of gas make their appearance in the mixture. If, however, the quantity of nitrate present be exceedingly small, it will require several hours, or even some days, to complete the reaction at the ordinary temperature. By the application, however, of heat,† and bringing the mixture to the boiling-point,

even in the case of the most dilute solutions, the reaction will be completed in a few moments. This development of colour under the circumstances stated is evidently due to the oxidation of the gallic acid, at the expense of the nitrous acid, whereby the compound known under the name of tanno-melanic acid seems to be formed, whilst nitric oxide and carbonic acid gases are evolved. The following equation represents the changes which occur in the reaction:—



These changes, with the development of colour, take place in neutral as well as in acid solutions, but more readily in the latter, and when they are heated than at the ordinary temperature, as already observed. The colouring principle which is so produced seems to be the same substance that is formed by the gradual oxidation of gallic acid in aqueous solution by exposure to the air; or when this takes place more rapidly, by the solution being rendered alkaline by the addition of one of the alkalies before exposing it to its influence. The colouring matter so formed is unaffected by diluted acids—at least diluted sulphuric, nitric, and hydrochloric acids had no apparent effect on it; and the organic acids, acetic, oxalic, and tartaric, even in a concentrated condition, did not seem to produce any change. It is also very permanent, and does not appear to be affected by exposure to the air and light, even after being for a long time subjected to their influence.

The depth or intensity of the colour produced being in direct proportion to the amount of nitrite reacting on the gallic acid, a ready means is afforded for the quantitative determination of the nitrites. Thus, if a standard solution be prepared, containing a known quantity of nitrite, and if a given amount of water or solution under examination yielded with gallic acid a certain shade or depth of colour, and if the same bulk of the standard solution, or of a mixture of it with distilled water in known proportion, developed the same tint, the former would be considered to contain the same amount of nitrite as the latter, and by thus comparing the tints produced by the waters under examination with those caused by solutions containing known quantities of nitrite, the quantitative estimation of such may be quickly accomplished, just as in Nessler's process (now so much employed by chemists) the determination of ammonia is so readily effected. Indeed the colour which is developed by the action of the nitrites on

* A paper read before the Royal Irish Academy, April 24, 1882.

† The continued application of heat has the effect of slightly diminishing the depth of colour developed in this reaction.

gallic acid most closely resembles that produced by ammonia on Nessler's reagent. The process, too, is conducted pretty much in the same way, except that we have a standard solution of an alkaline nitrite, instead of one of ammonia; and the test reagent is one containing gallic acid, instead of Nessler's solution; and finally, that the water or mixture, after the addition of the gallic acid solution, and a few drops of either sulphuric or hydrochloric acid, is heated to boiling in a test-tube and allowed to cool, after which it is placed in a cylindrical flat-bottomed glass, to compare more accurately the degree of colour produced by the water under examination with that containing some known quantity of nitrite.

The gallic acid solution which I have employed for the determination of nitrites is a strong or saturated aqueous one, which, if not colourless, can be easily made so by boiling it for a few minutes with animal charcoal, filtering the mixture whilst still warm, and then adding immediately to the filtrate sufficient sulphuric or hydrochloric acid to render it strongly acid, which addition I have found prevents, to a great extent, the tendency of aqueous solutions of gallic acid to become of a yellow or brownish tint on keeping, which well-known property is due, as already observed, to the tendency of that acid to oxidise under such circumstances; but by the addition of the acids stated, I have kept solutions of gallic acid, which were even exposed to the air in open vessels, for over two months without undergoing any change in colour.

As to the standard alkaline nitrite solution, it may be readily prepared by decomposing a hot aqueous solution of silver nitrite with potassium or sodium chloride, and after the subsidence of the silver chloride formed, diluting the solution to the required amount. The one I employed was made, as Dr. Frankland directs in his "Water Analysis," for the preparation of the standard alkaline nitrite solution to be employed in Griess's method for the determination of nitrites, which is prepared as follows:—0.406 grm. of pure silver nitrite is dissolved in boiling distilled water, and pure potassium or sodium chloride added, till no more silver chloride is precipitated. The solution is made up to one litre, and the silver chloride being allowed to settle, 100 c.c. of the clear solution is made up to one litre, of which 1 c.c. is equivalent, as he says, to 0.01 m.grm. of nitrous anhydride (N_2O_3); and he further adds, that this solution should be kept in closely-stoppered bottles, quite full. A solution at least double this strength will, however, be found more convenient for my test. I may also observe that I have likewise used a standard solution made by taking the commercial potassium nitrite and boiling it along with alcohol, which will dissolve out the potassium nitrite, leaving undissolved the nitrate and other impurities; and this alcoholic solution, on evaporation and drying the residue, will furnish the nitrite suitable for this purpose.

In using this test a convenient quantity of water to employ is 25 c.c., which can easily be heated in a test-tube of somewhat larger capacity, along with 1 or 2 c.c. of the gallic solution, and a few drops of sulphuric or hydrochloric acid, and, when the mixture has cooled, transferring it to a flat-bottomed cylindrical glass, where the depth of colour can be more readily determined, and compared with that yielded by equal bulks of different mixtures of the standard solution with distilled water. But where the amount of nitrite is very minute, it will perhaps be better to use at least 50 c.c. of the water under examination. I should observe that the nitrates do not produce the reaction described with gallic acid, and, unless they are present in large quantity, do not affect the test; and that it (the reaction with the nitrites) appears to be uninfluenced by the presence of the different saline and earthy salts that occur in natural waters, as well as by the organic matters that may be there occasionally. It might be naturally supposed that soluble salts of iron (which are sometimes present to some extent in certain waters), producing as they do the well-known black or ink-like reaction with gallic acid, would preclude its employment as a means of estimating

nitrites, where the former salts were present; but this is not the case, for the iron may be separated by the addition of ammonia and filtration, after which I have found that the filtrate, having been acidified, may be treated with gallic acid, for the estimation of nitrites. It appears, therefore, that none of the substances which would be likely to occur in natural waters interfere with the employment of this test.

As to what may be the exact limits of its indications, I have not yet been able to determine; but I have readily detected, by its use, an amount of nitrite in water equivalent to one part of nitrous acid in about twenty million parts of water.

I have made a number of comparative experiments with this test of mine and those hitherto proposed for nitrites, but chiefly with that of P. Griess, already referred to, as Dr. Frankland (who is one of the first chemists of the day) has stated in his "Water Analysis," that it is the only trustworthy means we have for the estimation of nitrites.

This test, I may briefly say, depends on the reaction of nitrous acid on metaphenylene diamine, or meta-diamidobenzol, a derivative of benzol, whereby an orange-coloured compound is produced, by the oxidation of this complex basic substance. This reaction is one of extreme delicacy, and the test is carried out pretty much in the same manner as the well-known Nessler's method for the determination of ammonia; or of mine, just described, for that of nitrites; the depth of colour produced by the test solution, with the water under examination, being compared with that of one containing a known quantity of nitrite; the details, however, of the method will be found fully stated in Dr. Frankland's "Water Analysis."

From several comparative experiments I have made with Griess's method and that of my own, I have come to the conclusion that the latter is almost, if not quite, as delicate a test for the nitrites as the former. I have, however, observed this difference between them, that when the proportion of nitrites present was considerable, that then Griess's test gave a more decided reaction, or that the colour produced was of greater intensity than in the case of the gallic acid test; but that when the amount of nitrite was exceedingly minute, that then there was but little or no difference in the delicacy of their indications. In some other respects, however, the test which I have proposed possesses advantages over that of Griess; thus the metaphenylene diamine is at present a compound very difficult to be procured; so much so that though I applied twice, lately, to one of the best known firms in London for the manufacture of chemicals (Messrs. Hopkin and Williams), they were unable to procure me a little of that substance; and that which I operated on was kindly given to me by my friend Dr. Tichborne, who procured it direct from Berlin. On the other hand, the reagent used in my test may be got for a few pence at any druggist's shop. Again, Griess's test solution will not keep, as it quickly acquires the same colouration that is produced by the reaction of nitrous acid or a nitrite on it, even when it is kept in closely-stoppered bottles; and therefore requires to be freshly made and titrated almost every time it is employed; whereas the gallic acid solution which I have recommended will, I find, keep for a very considerable time without apparently undergoing any alteration requiring its fresh titration, which is an important advantage. In conclusion, I may add, that whatever may be the comparative merits of the two tests contrasted, I have but little doubt that the one I have proposed will be found to be a useful and expeditious method for both the qualitative and quantitative determination of the nitrites under different circumstances.

Determination of Carbon Disulphide.—E. A. Grete and J. Macagno.—Both authors ascertain the quantity of copper which can be precipitated by the xanthogenic acid obtained on treating the carbon disulphide with alcoholic solution of potassa.—*Zeitsch. f. Anal. Chem.*

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Zirconia.

The boiling solution is treated with an excess of solution of potassa. The precipitate of zirconia requires prolonged washings, and retains traces of gallia, which are extracted by re-solution in hydrochloric acid and re-precipitation by potassa. Two or three treatments with boiling potassa generally suffice. The gallium oxide is freed from potassic salts by supersaturation, first with hydrochloric acid, and then with ammonia and prolonged boiling, or more accurately by means of cupric hydrate. Only feeble traces of zirconia pass into the alkaline solution, which are separated from gallium by potassa at the end of the analysis.

Arsenic sulphide also effects the separation of zirconium and gallium, and especially to detect small traces of gallium masked by much zirconium. The liquid charged with acid ammonium acetate and arsenious acid is treated with sulphuretted hydrogen, as already indicated.

Ferrocyanide cannot be used, as it gives a canary-yellow precipitate in solutions of zirconia, even if very acid and very dilute. Ebullition even does not effect the solution of the precipitate in a liquid containing two-thirds of its bulk of concentrated hydrochloric acid. This fact is mentioned because certain chemical treatises assert that potassium ferrocyanide gives a precipitate in neutral solutions of zirconium, but not in such as are acid.

Separation from Manganese.

The author has found the nine following methods effective:—

1. He treats the boiling liquid with an excess of aqueous potassa. The precipitate contains a quantity of gallium, and is re-dissolved in hydrochloric acid and treated afresh with potassa. This process is repeated four or five times; the alkaline solutions collected together are concentrated and filtered to separate a little brown manganese oxide. The gallium is removed from the alkaline salts by ebullition with ammonia, or with cupric hydrate. If the proportion of manganese is very considerable this process loses much of its advantage, because of the difficulty of washing completely the bulky deposits of manganese oxide.

2. The hydrochloric solution, distinctly acid, is kept at a boil for some minutes (which reduces the manganese per-salts); it is then supersaturated with ammonia, and boiled until it reddens litmus-paper; the water lost by evaporation is constantly replaced. The gallium oxide obtained sometimes retains traces of brown manganese oxide; it is then re-dissolved in hydrochloric acid, and the ammoniacal ebullition is repeated, taking care not to add the ammonia until the acid liquid has boiled for a few minutes.

3. Barium carbonate separates gallium in the cold in twelve to eighteen hours, leaving manganese chloride dissolved. Traces of manganese may be found in the precipitate, but they are eliminated after the separation of the barium and gallium by means of boiling with ammonia or cupric hydrate.

4. Calcium carbonate may be used in the same manner as barium carbonate.

5. If iron is present it is advisable to eliminate a good part of this metal at the same time as the manganese. For this purpose the hot acid liquid is reduced by sulphurous acid gas or sodium sulphite. After boiling for a few moments the author adds a small excess of calcium carbonate, and filters. (The separation of the calcium and gallium is effected in the ordinary manner. This method is especially useful in extracting gallium from its ores.)

6. Cupric hydrate, applied hot, affords an excellent means for separating gallium from manganese. The process is conducted as has been previously described.

7. In presence of iron the liquid may be first reduced

by metallic copper and the gallium precipitated by means of the cuprous oxide. This process is as accurate as that with cupric hydrate.

8. When the quantity of gallium is very small in comparison with the mass of manganese salts, it is sometimes advantageous to use the reaction of arsenic sulphide formed in a solution supersaturated with acid ammonium acetate. Manganese sulphide is not formed under these conditions. The separation is very good.

9. The reaction of potassium ferrocyanide is applicable to the precipitation of gallium mixed with manganese compounds, but it is necessary to operate in an especial manner, for the presence of manganese chloride modifies the action of ferrocyanide upon gallium chloride. If we divide into two equal parts a very dilute and very acid solution (containing one-third of its volume of hydrochloric acid) of gallium chloride, and introduce into one of the halves manganese chloride, the addition of equally very small quantities of ferrocyanide produces very different effects in the two vessels. The solution of gallium alone becomes abundantly turbid, whilst the solution containing manganese remains at first clear, and then slowly deposits a reddish brown precipitate which contains the gallium. This brown precipitate is re-dissolved if heated with its mother-liquid, and is slowly reproduced on cooling. The precipitate formed in the liquid free from manganese does not dissolve in its mother-liquid if raised to a boil, but it dissolves in heat if some manganese chloride is previously added to the mother-liquor. After cooling, the reddish brown precipitate is then gradually produced.

If, instead of pouring very little prussiate into the solution of gallium and manganese, we add much, the brown precipitate is formed at once, but retains its property of being dissolved in heat and re-precipitated when cold.

If a clear, very acid solution, containing gallium chloride, an excess of manganese chloride, and ferrocyanide, is kept at a temperature of 70° to 80°, there is soon formed a turbidity, not brown, but white with a blue cast; it is in appearance the ordinary precipitate of gallium ferrocyanide, but it does not dissolve if heated with the excess of the salt of manganese. This precipitate contains all the gallium. In the liquid, when cold, the deposit does not turn brown. By operating as follows an accurate separation of gallium and manganese can be effected with ferrocyanide.

The solution containing about one-third of its volume of concentrated hydrochloric acid is raised to 70°; a quantity of ferrocyanide is then added, not too great, in order to avoid the formation of much Prussian blue, but still larger than if it was required to precipitate the same weight of gallium in the cold in presence of metals such as aluminium or chromium. The ferrocyanide should be neither too dilute, nor acidified with hydrochloric acid. Drops of moderately concentrated ferrocyanide give, on contact with the highly acid liquid, a white precipitate, which would be equally formed with hydrochloric acid alone, and which re-dissolves on stirring if the quantity of ferrocyanide is small. The momentary presence of this slight turbidity incites and accelerates the deposition of the gallium ferrocyanide. The liquid is stirred frequently, and is kept at about 70° for 30 to 60 minutes; then filtered, the deposit washed with water containing one-fourth hydrochloric acid, and heated to 70°. 0.001 grm. of gallium, corresponding to 0.0025 grm. of gallium chloride, may be recovered in this manner without appreciable loss, from 200 c.c. of a very acid solution containing 12.5 grm. of anhydrous manganese chloride. The limit of the sensibility of the process is not reached here, though the liquid contains merely 1-200,000th of gallium, and the gallium chloride bears to the manganese chloride the proportion 1 : 5000. If from deficient washing or otherwise the gallium ferrocyanide retains traces of manganese, these are naturally eliminated during the treatment necessary to separate gallium from iron, such as the boiling with ammonia of the product of the action of

bisulphate upon the oxides, and the action of metallic copper and cuprous oxide.

Separation from Zinc.

The hydrochloric solution, very strongly acid, is supersaturated with ammonia and boiled till it reddens litmus, the water driven off being replaced. Care must be taken that the liquid when cold does not cease to redden litmus, which will happen if traces of zinc oxide remain unattacked. If the gallium oxide retains a little zinc oxide it is re-dissolved by hydrochloric acid in excess and the boiling with ammonia is repeated.

Cupric hydrate separates gallium accurately from zinc. The process is conducted with the aid of heat, on principles already laid down. In case of need the operation is repeated. When, in addition to zinc, iron is present in the solution it is better to reduce with metallic copper and precipitate with cuprous oxide. The separation is as exact as with cupric hydrate. The zinc being much more readily eliminated than the iron, the latter metal is the chief object of concern.

Barium and calcium carbonates precipitate gallium oxide in the cold, but the deposits contain considerable quantities of zinc oxide, especially if barium carbonate has been used. These two reagents can only be employed when it is required to concentrate gallium into a small volume, and cannot be admitted in an exact analysis. The same observation applies to the precipitation of gallium by calcium carbonate at a boil after sulphurous reduction. There is much zinc in the deposit, however short the boiling has been, especially if the excess of calcium carbonate is considerable. The treatment with calcium carbonate in heat, after reduction with sulphurous acid, though not suitable for analysis is very advantageous for the extraction of gallium from its ores, since by repeating the process two or three times we may eliminate almost all the zinc, the greater part of the iron, and many other bodies.—*Comptes Rendus*.

A NEW METHOD OF DETERMINING PHOSPHORIC ACID.*

By HENRY PEMBERTON, Jun.

THE process I am about to describe, and which I first tried in the summer of 1879 and have used since that time, consists in titrating phosphoric acid by direct precipitation, by means of a standard solution of molybdate of ammonia.

The principle is the same as that of Gay-Lussac's silver estimation, or Wildenstein's estimation of sulphuric acid by barium chloride; the standard solution is run in until further addition no longer causes a cloud, and the volume then read off.

Any one who has used ammoniac molybdate for separating P_2O_5 in the usual gravimetric determination will at once see that the following obstacles will have to be overcome:

- (1). The usual nitric acid solution of the molybdate is not stable, and is therefore unfitted to act as a standard solution, on account of the gradual separation of molybdic acid.
- (2). The yellow precipitate does not separate completely until after the lapse of considerable time.
- (3). A decided excess of the molybdate must be added to insure the complete precipitation of the P_2O_5 .
- (4). The precipitate has not always the same composition, being frequently mixed with free molybdic acid.

Two expedients have enabled me to overcome these difficulties: the use of an aqueous solution of ammoniac molybdate, instead of the ordinary nitric acid solution—first advocated by John Parry (CHEMICAL NEWS, vol. xxv.)

* Read before the Chemical Section of the Franklin Institute, Feb. 7, 1882.

—and the addition to the phosphate solution of a considerable quantity of nitrate of ammonia, in which the yellow precipitate is as good as insoluble—recommended by E. Richters (*Journ. Chem. Soc.*, 24, p. 157).

By so doing I have found that the standard solution is perfectly stable, that the yellow precipitate falls immediately and completely, that a very small and definite excess ($\frac{1}{2}$ c.c.) of the molybdate is required, and that the ratio of molybdic trioxide to phosphoric anhydride is always the same.

Briefly stated, then, the process consists in adding nitrate of ammonia to the phosphate solution, using a limited quantity of nitric acid, and running in, from a burette, an aqueous solution of ammoniac molybdate until, after the settling of the precipitate, the further addition of the standard solution leaves the liquid clear.

Starting out, as I did, completely in the dark, my first object was to get some general idea of the working of the proposed method. Therefore, without being exact in weights, I dissolved about 10 grms. of the molybdate in 100 c.c. of water, and made a phosphate of soda solution of such strength that 50 c.c. should equal 0.1000 gm. P_2O_5 . 25 c.c. of this phosphate solution was then treated with 2 c.c. nitric acid, of 1.4 specific gravity, and with 10 grms. nitrate of ammonia. It was then heated, and the molybdate solution run in from a burette. The first drop caused an immediate precipitate. This was continued until, after settling of the yellow precipitate (which is quite rapid), further addition left the solution clear. I found, in three trials, that 25 c.c. of the phosphate solution required 15.8 c.c., 16.0 c.c., 15.7 c.c. of the molybdenum solution. This same was then repeated, but the final point was determined by filtering a little of the solution and testing it by the molybdate. 25 c.c. required 15.5 c.c., 15.3 c.c., 15.5 c.c., showing that in the first three trials, where the end of the reaction was shown by the settling of the precipitate, the point was somewhat overstepped. In all the following experiments, therefore, the end of the precipitation was determined by allowing the yellow salt to settle, filtering a little of the solution through a small filter, heating this clear filtrate, and testing it with more of the molybdate.

Nitric Acid.—Repeated above, using 5 c.c. HNO_3 , 1.4 sp. gr., in place of 2 c.c. Required 16.0 c.c., 16.0 c.c., showing that a greater quantity of the molybdate is necessary in order to counteract the solvent action of the excess of nitric acid.

Ammoniac Nitrate.—Proceeded as above, 2 c.c. HNO_3 , but used 20 grms. ammoniac nitrate in place of 10 grms., as before. Required 15.5 c.c., 15.5 c.c., proving that 10 grms. is sufficient when the total volume of the solution is not over 100 c.c., or thereabout.

Dilution.—As above, 10 grms. NH_4NO_3 , 2 c.c. HNO_3 , but diluted the solution so that the volume when finished equalled 130 c.c., instead of from 50 to 70 c.c., as above. Required 15.6 c.c., showing that dilution, within moderate limits, does not affect the result.

Oxides of Iron and Alumina.—As above, but added 0.057 gm. Fe_2O_3 , dissolved as nitrate, and 0.034 Al_2O_3 , present as neutral tersulphate. Required 15.5 c.c., proving that these sesquioxides—at least when present in above quantities—do not interfere.

The above were all preliminary trials, made merely to enable me to feel my way. Feeling encouraged by the results, I proceeded to make a more thorough examination.

10.085 grms. disodic hydric phosphate were dissolved in water and made up to 1000 c.c. The amount of P_2O_5 in 50 c.c. of this solution was then determined by precipitation and weighing as magnesian pyrophosphate, and also by evaporating, igniting, and weighing as sodic pyrophosphate. I found in 50 c.c.—

By $Mg_2P_2O_7$	..	..	0.1010 gm. P_2O_5
" "	..	..	0.1009 " "
" $Na_4P_2O_7$	13	1.5	0.1012 " "
Average =	..	..	0.10103 " "

Showing that the salt before weighing had effloresced about 1 per cent.

93 grms. ammonic molybdate $[3(\text{HN}_3)_2\text{O} \cdot 7\text{MoO}_3 \cdot 4\text{H}_2\text{O}]$ were dissolved in water and made up to 1 litre, a slight cloudiness being removed by addition of a few drops of ammonic hydrate.

50 c.c. of the phosphate of soda solution were then measured into a beaker, treated with 10 grms. NH_4NO_3 and with one c.c. HNO_3 , 1.40 sp. gr., and then warmed. Ammonic molybdate was then run in, but not a trace of a precipitate formed; but on adding another c.c. of nitric acid a dense precipitate immediately formed. After adding still a third c.c. of nitric acid 32.9 c.c. of the molybdate were required for entire precipitation. Using, therefore, 10 grms. NH_4NO_3 , 2 c.c. HNO_3 , 1.4 sp. gr., and titrating with the solution of 93 grms. molybdate to the litre, I found that 50 c.c. P_2O_5 solution required, when the volume at the end was

115 c.c.		32.5 c.c.	} Mean = 32.70 c.c.
		32.8 c.c.	
		32.7 c.c.	

When the volume at the end was

60 c.c. to 70 c.c.	..	32.8 c.c.	} Mean = 32.85 c.c.
		32.9 c.c.	

Again, when volume =	120 c.c.,	} Mean = 32.90 c.c.
	33.0 c.c.	
	32.8 c.c.	

The means, therefore, were: 32.70 c.c.
32.85 c.c.
32.90 c.c.

General mean = 32.82 c.c.

to precipitate 0.1000 grm. P_2O_5 . Therefore 0.1000 grm. P_2O_5 would require 32.48 c.c.

It is well known that in the usual way of precipitating this yellow salt, where a large quantity of nitric acid is present, a considerable excess of the molybdate is required. Having this in view, I tried the following experiment. Since 50 c.c. of the P_2O_5 solution require, as above, 32.82 c.c. molybdate, 5 c.c. should require one-tenth of this, or 3.28 c.c. I found, however, that 5 c.c. required, in two trials, 3.7 c.c. and 3.7 c.c., an excess of 0.42 c.c. Again, 1.5 c.c. P_2O_5 solution (= 3 per cent. of 50 c.c.) should require 3 per cent. of 32.82 c.c. = 0.98 c.c. By experiment 1.45 c.c. were required, an excess of 0.47 c.c. As it is not required to differentiate more finely than to the 1.10th c.c., it appears that 0.5 c.c. excess is required, first to neutralise the slight solvent power of the HNO_3 present, and secondly to precipitate the small quantity of P_2O_5 held back in the pores of the filter paper in the final testing. Subtracting, therefore, this 0.5 c.c., we find that 0.10103 grm. P_2O_5 require 32.82 c.c. - 0.5 c.c. = 32.32 c.c. Therefore 0.1000 grm. P_2O_5 require 32.00 c.c. molybdate.

Ratio of MoO_3 to P_2O_5 .—Ammonic molybdate contains, when perfectly pure, 81.55 per cent. MoO_3 . One determination of the sample I used (of German manufacture) gave me, by Chatard's method, 81.27 per cent. MoO_3 . Using the theoretical figures, a litre of molybdate solution containing 93 grms. will contain 75.8415 grms. MoO_3 . 32 c.c., therefore, will contain 2.4269 grms. MoO_3 , this representing the amount required to precipitate 0.1000 grm. P_2O_5 . Therefore $\text{MoO}_3 : \text{P}_2\text{O}_5 :: 24.269 : 1$. This represents the ratio by weight.

Dividing by the molecular weight of each (144 and 142 respectively) we get 23 93-100ths molecules* of MoO_3 to 1 molecule P_2O_5 , or practically 24 to 1.

This is precisely the figure established by Finkner, and still more recently by Dr. Gibbs in his investigation into the phospho-molybdates, just published in a recent number of the *American Chemical Journal*.

* Even if calculated upon the basis of 81.27 per cent. MoO_3 in the molybdate (as per my analysis), the result is practically the same, viz.: 23 83-100ths MoO_3 to P_2O_5 .

The agreement of these results, obtained in entirely different ways (those of Finkner and Gibbs by analysis, mine by synthesis) prove what I previously asserted in regard to the constancy and reliability of results by this process. In the ordinary gravimetric determination of P_2O_5 , where the latter is separated by the nitric acid solution of the molybdate, the solution has to stand in the heat for several hours and in the presence of a decided excess of the reagent. It is therefore impossible to guarantee the admixed molybdic acid, and almost every chemist analysing the per cent. of P_2O_5 in the yellow salt obtained a different result. It is, accordingly, this fact that has prevented the universal adoption of the yellow precipitate as a basis upon which to calculate the phosphoric acid.

I have, therefore, gone somewhat minutely into this question, to prove that these sources of error do not exist in this volumetric process.

Action of Nitric Acid.—I found that 50 c.c. of the P_2O_5 solution require—

(With 1 c.c. HNO_3 1.4 sp. gr.—	no precipitate)
" 2 " " "	32.8 c.c.
" 3 " " "	32.9 "
" 5½ " " "	33.2 "
" 10½ " " "	33.8 "—is not enough.

Action of Chlorides.—10 c.c. P_2O_5 solution should require 6.46 c.c. With 5 grms. NH_4Cl added required in two trials 6.60 and 6.65 c.c. Again, 10 c.c. P_2O_5 solution with 1.17 grm. CaCl_2 added require 6.55 c.c. Again, 5 c.c. of another P_2O_5 solution which should require 4.90 c.c., when treated with 1 c.c. HNO_3 and 1 c.c. strong HCl , requires 4.90 c.c. Hence chlorides do not seem to have any appreciable effect.

Temperatures.—The solution containing the phosphate has to be quite hot; a steam should play upon the surface of the liquid. One determination showed 136° F.; this should certainly be regarded as the minimum. A solution of known strength, to which about 90 per cent. of the molybdate required had been added, and which had been kept only slightly warm, was filtered, and the filtrate heated. A decided yellow precipitate at once formed. From 140° to 160° F., or even somewhat higher, appears to be about the correct temperature.

Action of Silicic Acid.—Halloysite was decomposed with sulphuric acid, the silica filtered, washed, and boiled repeatedly with HCl . Again washed, dried, and ignited. 0.1725 grm. of this ignited silica was fused with Na_2CO_3 , dissolved in water, neutralised with HNO_3 , treated with 10 c.c. P_2O_5 solution, and then titrated. It should have required 6.45 c.c. molybdate, but did require 7.5 c.c., and even when 8.7 c.c. had been added, gave with more molybdate, at first a yellow colour, and after standing, a faint cloud. Silicic acid therefore interferes.

Action of Organic Matter.—The material used for this purpose is what is known in the trade as "azotine" or "ammonite." Refuse from slaughter-houses, dead animals, &c., are subjected to a treatment with hot benzine, by which the fat is extracted. The residue consists of a certain amount of bone with every variety of organic matter except the fat, and as it comes into the market in a fine dry powder, is well adapted to examination, weighing, &c. It was with particular reference to the analysis of fertilisers that I selected this substance as a typical form of organic matter likely to be found in these.

Before examining this, there are a few points to be noticed. First, Mulder has shown (*Chem. Gazette*, vii., p. 62) that higher results are obtained by treating organic compounds containing phosphorus with HNO_3 than are obtained by dissolving in HCl . He finds that the excess of P, oxidised by HNO_3 over the quantity dissolved by HCl , and calculated into phosphoric acid, to be, with albumen, 0.99 per cent, albumen in blood 0.76 per cent, fibrin 0.76. It has not been established that phosphorus, in organic combination, is of any value as plant-food. In fact, from the nature of the case, it never will be decided.

Secondly. Although shown by Kastner to be the case

over half a century ago, it is, in all probability, not generally known that the phosphoric acid in calcined bones exists not as ortho-phosphoric acid, but chiefly as pyro- or meta-phosphoric acid; and this, too, in spite of the fact that three atoms of base are present.

Thirdly. In igniting the azotine, to burn off the organic matter, the small quantity of dirt, sand, &c., always present yields a certain amount of soluble silicic acid, on subsequent treatment with acid, and this will interfere, unless the solution is evaporated to dryness.

The following are the analyses of several brands of this azotine:—By "volumetric" is meant that the determination is made by titration with ammonic molybdate. By MoO_3 and MgO that the usual gravimetric method was used.

Volumetric. Ignited azotine, evaporated to dryness,	14.19 per cent P_2O_5 .
" " " not " " "	14.50 " "
" " " not " " "	" "
" " (2nd analysis) " " "	14.64 " "

showing the action of silica.

Volumetric. Raw azotine (not ignited) dissolved in HNO_3 , evaporated twice	15.05 per cent.
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showing the action of oxidising agents.

Another sample gave—

MoO_3 and MgO , raw azotine, HCl solution,	2.87 per cent P_2O_5 .
Volumetric " " "	2.73 " "
" " (repeated) " " "	2.67 " "
" Ignited, evaporated to dryness " " "	2.90 " "
" Same repeated " " "	3.06 " "
" Ignited (not evap., action of SiO_2) " " "	3.20 " "

Another sample—

$\text{MoO}_3 + \text{MgO}$ raw azotine	4.45 per cent P_2O_5 .
Volumetric " " "	4.57 " "
" " $\text{HNO}_3 + \text{KClO}_3$ " " "	5.21 " "
" Same repeated, " " "	5.60 " "
" Ignited but not evaporated, " " "	4.84 " "
" Same repeated, " " "	4.91 " "

I now made a mixture of acid phosphate of lime from South Carolina phosphate rock and sulphuric acid, containing (about)

9 per cent soluble P_2O_5
3½ " reverted "
2½ " insoluble "
—
15 per cent total.

This was mixed so as to contain in 100 parts of the above acid

Phosphate	79 parts
Azotine	16 "
Potassium chloride	5 "
	100 "

and this mixture, after being finally ground and averaged, was analysed as follows:—

By $\text{MoO}_3 + \text{MgO}$ (not ignited) ..	13.32 per cent P_2O_5
Volumetric, ignited, evaporated to dryness	13.25 " "
(Showing no loss from formation of pyrophosphate).	
Volumetric, not ignited, HCl solution	13.11 " "
evaporated	13.07 " "
Volumetric, not ignited, HCl solution	13.24 " "
not evaporated	14.03 " "

Again, the above mixture was leached, filtrate not measured, but 25 c.c. (=about 0.8 gm.) taken for each trial.

By $\text{MoO}_3 + \text{MgO}$ (evaporated to dryness with HCl)	70.7 mgr. P_2O_5
Volumetric, " " " ..	69.3 " "
" " not evaporated	71.1 " "

From the above it appears that by dissolving in HNO_3 and evaporating to dryness, the results are above the truth; by dissolving in HCl , the result may be 0.1 per cent to 0.2 per cent low; by igniting and not evaporating, the silica will interfere; but that by igniting and evaporating to dryness the results are correct, or vary only within the limits of instrumental errors.

I have observed no difficulty in working with pyrophosphates, provided that the ignition be carried on at not too high a temperature, and the evaporation with nitric acid be repeated.

Citric, tartaric, and oxalic acids interfere and must not be present. When the oxalic acid is oxidised by permanganate, the yellow precipitate falls immediately.

The following is a condensed description of the *modus operandi* in performing the analysis.

89.5430 grms. ordinary ammonic molybdate are put into a litre flask, water added, and the whole shaken until the salt dissolves. If a cloudiness is left in the liquid, a little ammonic hydrate is added. A small excess of this is not objectionable. The flask is then filled to the mark.

The above weight of the molybdate is calculated so as to give MoO_3 to P_2O_5 exactly as 24:1. Each c.c. precipitates 3 milligrammes P_2O_5 . It differs from the figure obtained empirically by an amount equal to only 0.0003 gm. P_2O_5 in a determination of 0.1000 gm. P_2O_5 .

The phosphate to be examined is then taken in quantity containing not over 0.1000 gm. P_2O_5 or 0.1500 gm. at the utmost. If silica is present the solution is evaporated to dryness. In presence of organic matter ignite gently and evaporate to dryness twice with HNO_3 . There is no advantage in filtering off the SiO_2 . The solution is transferred to a beaker of 100 to 125 c.c., using as little water as possible to prevent unnecessary dilution, and is just neutralised with NH_4HO , i.e., until a slight precipitate is formed.

If much iron is present the ammonia is added until the yellow colour begins to change to a darker shade. 2 c.c. of nitric acid are added. Care must be taken that the sp. gr. of the acid is not less than 1.400, otherwise more must be added. 10 grms. of granular nitrate of ammonia are now added. After a little experience the quantity can be judged with sufficient accuracy by the eye without the trouble of weighing. The solution is now heated to 140° F. or over and the molybdate solution run in (most conveniently from a Gay-Lussac burette), meanwhile stirring the liquid. The beaker is now left undisturbed for about a minute on the water-bath or hot plate and the precipitate settles, leaving the supernatant liquid not clear but containing widely disseminated particles, in which the yellow cloud can easily be seen on the further addition of the molybdate. This addition is continued as long as the precipitate is thick and of a deep colour. But as soon as it becomes rather faint and thin, a little of the solution, about 2 to 3 c.c., after settling of the precipitate, is filtered through a small filter (not over 5 c.m. in diameter) into a very small beaker, and this is heated on a hot plate and 4 or 5 drops of the molybdate added. If a precipitate is produced the whole is poured back into the large beaker and a further addition of the molybdate (1, 2, or 3 c.c.) added, according to the quantity of the precipitate in the small beaker. After stirring and settling, another small quantity is filtered through the small filter and again tested. If the mark has been overstepped and too much molybdate added, a measured quantity of P_2O_5 solution of known strength is added, and the corresponding amount of P_2O_5 deducted. In filtering through the small filter the liquid held sometimes in the neck of the funnel must be allowed to run out.

I generally check my results by adding a c.c. of standard P_2O_5 solution, and then again testing. This can be re-

peated as often as desired. The portion that last produces a cloud is the final point. From this is subtracted 0.5 c.c. (for neutralising the solvent action of the HNO_3 , as above explained), and the remainder multiplied by 3 gives the weight of P_2O_5 in milligrammes.

One decigramme of P_2O_5 gives about 24 grms. of the yellow precipitate, and the accuracy of the process is largely due to this smallness of the percentage of the P_2O_5 .

The ammoniac molybdate is now prepared in a state of great purity. Several samples that I have bought did not vary in strength to any appreciable extent. It may, possibly, contain a trace of phosphoric acid, which, however, does not affect the result, since it will have the same weakening action in the standardising tests that it has in the actual analysis.

I have used this process entirely in determining phosphoric acid in materials containing it in quantity, e.g., apatite phosphate rock, fertilisers, &c.

It is not adapted to the direct determination of minute quantities of phosphorus in iron or iron ores. At least 5 grms. of the ore must be taken, and in the concentrated solution formed by this quantity of the iron salt and the nitrate of ammonia, the precipitate settles slowly on account of the density, and is seen with difficulty because of the depth of colour. Moreover, I have observed that a solution of ferric nitrate shows a somewhat peculiar behaviour on addition of ammoniac molybdate; molybdic acid at once separates in a curdy precipitate which redissolves on stirring. This reaction does not take place when iron is absent. Ferric nitrate, moreover, has the effect of retarding the precipitation somewhat, and it, therefore, is more difficult to see how the precipitation is proceeding when Fe_2O_3 is present in quantities exceeding a decigramme or so. These properties are peculiar to iron oxide only, and not to alumina.

In working with unknown quantities the titration requires about an hour for its performance. Of all the forms of volumetric analysis, that one in which the final point is determined by the cessation of the precipitation is the least desirable. And were it not that the ordinary method requires a day rather than an hour (including at least two precipitations of the magnesia salt), the process of direct precipitation above described would hardly be able to hold its own in comparison.

I have obtained very sharp and accurate results by determining the amount of the yellow precipitate (formed as above, after thorough washing), by means of a standard solution of caustic alkali, using litmus as an indicator; a description of which I hope to present in a future paper. I mention it here simply to place the fact on record.—*Journal of the Franklin Institute.*

RULES AND REGULATIONS RECOMMENDED FOR THE PREVENTION OF FIRE RISKS FROM ELECTRIC LIGHTING.*

Members of the Committee.—Professor W. G. Adams, F.R.S., Vice-President; Sir Charles T. Bright; T. Russell Crompton; R. E. Crompton; W. Crookes, F.R.S.; Warren De la Rue, D.C.L., F.R.S.; Professor G. C. Foster, F.R.S., Past President; Edward Graves; J. E. H. Gordon; Dr. J. Hopkinson, F.R.S.; Professor D. E. Hughes, F.R.S., Vice-President; W. H. Preece, F.R.S., Past President; Alexander Siemens; C. E. Spagnoletti, Vice-President; James N. Shoolbred; Augustus Stroh; Sir William Thomson, F.R.S., Past President; Lieut.-Colonel C. E. Webber, R.E., President.

* Recommended by the Council of the Society of Telegraph Engineers and of Electricians in accordance with the Report of the Committee appointed by them on May 11, 1882, to consider the subject.

THESE rules and regulations are drawn up not only for the guidance and instruction of those who have Electric Lighting Apparatus installed on their premises, but for the reduction to a minimum of those risks of fire which are inherent to every system of artificial illumination.

The chief dangers of every new application of electricity arise mainly from ignorance and inexperience on the part of those who supply and fit up the requisite plant.

The difficulties that beset the electrical engineer are chiefly internal and invisible, and they can only be effectually guarded against by "testing" or probing with electric currents. They depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to waste of energy and the production of heat. These defects can only be detected by measuring, by means of special apparatus, the currents that are, either ordinarily or for the purpose of testing, passed through the circuit. Bare or exposed conductors should always be within visual inspection, since the accidental falling on to, or the thoughtless placing of other conducting bodies upon, such conductors might lead to "short circuiting" or the sudden generation of heat due to a powerful current of electricity in conductors too small to carry it.

It cannot be too strongly urged that amongst the chief enemies to be guarded against are the presence of moisture and the use of "earth" as part of the circuit. Moisture leads to loss of current and to the destruction of the conductor by electrolytic corrosion, and the injudicious use of "earth" as a part of the circuit tends to magnify every other source of difficulty and danger.

The chief element of safety is the employment of skilled and experienced electricians to supervise the work.

I. THE DYNAMO MACHINE.

1. The Dynamo Machine should be fixed in a dry place.
2. It should not be exposed to dust or flyings.
3. It should be kept perfectly clean and its bearings well oiled.
4. The insulation of its coils and conductors should be perfect.
5. It is better, when practicable, to fix it on an insulating bed.
6. All conductors in the Dynamo Room should be firmly supported, well insulated, conveniently arranged for inspection, and marked or numbered.

II. THE WIRES.

7. Every switch or commutator used for turning the current on or off should be constructed so that when it is moved and left to itself it cannot permit of a permanent arc or of heating, and its stand should be made of slate, stoneware, or some other incombustible substance.
8. There should be in connection with the main circuit a safety fuse constructed of easily fusible metal which would be melted if the current attain any undue magnitude, and would thus cause the circuit to be broken.
9. Every part of the circuit should be so determined that the gauge of wire to be used is properly proportioned to the currents it will have to carry, and changes of circuit, from a larger to a smaller conductor, should be sufficiently protected with suitable safety fuses so that no portion of the conductor should ever be allowed to attain a temperature exceeding 150° F.

N.B.—These fuses are of the very essence of safety. They should always be enclosed in incombustible cases. Even if wires become perceptibly warmed by the ordinary current, it is a proof that they are too small for the work they have to do, and that they ought to be replaced by larger wires.

10. Under ordinary circumstances complete metallic circuits should be used, and the employment of gas or water pipes as conductors for the purpose of completing the circuit should in no case be allowed.

11. Where bare wire out of doors rests on insulating supports it should be coated with insulating material, such

as india-rubber tape or tube, for at least two feet on each side of the support.

12. Bare wires passing over the tops of houses should never be less than seven feet clear of any part of the roof, and they should invariably be high enough, when crossing thoroughfares, to allow fire escapes to pass under them.

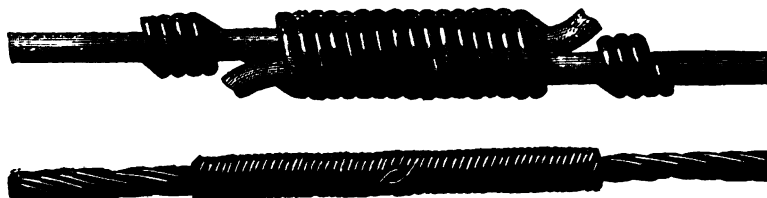
13. It is most essential that the joints should be electrically and mechanically perfect. One of the best joints is that shewn in the annexed sketches. The joint is whipped around with small wire and the whole mechanically united by solder.

14. The position of wires when underground should be efficiently indicated, and they should be laid down so as to be easily inspected and repaired.

15. All wires used for indoor purposes should be sufficiently insulated.

16. When these wires pass through roofs, floors, walls, or partitions, or where they cross or are liable to touch metallic masses like iron girders or pipes, they should be thoroughly protected from abrasion with each other or with metallic masses, by suitable additional covering; and where they are liable to abrasion from any cause or to the depredations of rats or mice, they should be sufficiently encased in some hard material.

17. Where wires are put out of sight as beneath flooring, they should be thoroughly protected from mechanical injury, and their position should be indicated.



N.B.—The value of frequently testing the wires cannot be too strongly urged. It is an operation, skill in which is easily acquired and applied. The escape of electricity cannot be detected by the sense of smell as can gas, but it can be detected by apparatus far more certain and delicate. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering, by electric action.

III. LAMPS.

18. Arc lamps should always be guarded by proper lanterns to prevent danger from falling incandescent pieces of carbon, and from ascending sparks. Their globes should be protected with wire netting.

19. The lanterns and all parts which are to be handled should be insulated from the circuit.

IV. DANGER TO PERSON.

20. To secure persons from danger inside buildings, it is essential so to arrange the conductors and fittings, that no one can be exposed to the shocks of alternating currents exceeding 60 volts; and that there should never be a difference of potential of more than 200 volts between any two points in the same room.

21. If the difference of potential within any house exceeds 200 volts, whether the source of electricity be external or internal, the house should be provided outside with a "switch," so arranged that the supply of electricity can be at once cut off.

By order of the Council,
F. H. WESS, Secretary.

Offices of the Society,
4, The Sanctuary, Westminster,
June 21, 1882.

Caffeine.—M. Taurer denies the existence of salts of caffeine containing organic acids. Such acids augment the solubility of caffeine in water, but are not neutralised by its presence.—*Journal de Pharmacie et de Chimie*.

NOTE ON FILTERING DISCS.

By P. CASAMAJOR.

In the *CHEMICAL NEWS* of April 21st (vol. xlv., p. 167), Mr. Grosjean refers to the plan proposed by him in 1879, (*CHEMICAL NEWS*, vol. xxxix., p. 182), of using ordinary conical funnels with the filtering discs described by me in 1875,* instead of the special funnel I had proposed. When Mr. Grosjean first published this plan I tried it, and found it very good, provided the perforated platinum disc is placed perpendicularly to the axis of the funnel. This condition is easily fulfilled by soldering, with gold, a platinum wire on the under side of the disc and perpendicular to it. If provided with this appendage the disc, when placed in the funnel, will drop into its proper position, as the wire, acting as a guide, will find its place in the stem of the funnel.

The idea of using a wire on a filtering disc for this purpose is due to Mr. J. Creagh Smith, who proposed it in the *American Chemical Journal*, vol. i., p. 368, for a cylindrical funnel, but it is equally applicable to a conical one.

Before dropping the platinum disc in the funnel, a circular piece of filter paper, slightly larger than the platinum plate, should be placed on its upper surface and thoroughly soaked with water. The wet paper will adhere to the

platinum plate and drop down with it. The edges of the paper are then pressed against the funnel to form a tight joint all around the filtering disc.

A filtering disc covered with filter-paper, with a disc over this, forms a perfectly air-tight joint, with much less trouble than is required with a platinum cone and a conical filter. When a precipitate is to be collected for ignition, filtering discs, used in this way, present this objection, that the precipitate lies partly on the glass funnel, and it has to be brushed off or scraped off. The loss from this may be inappreciable if this is done carefully and skilfully, but this is certainly an objectionable trait.

This difficulty may be easily overcome by lining the funnel with filter-paper from near its top to about 5 millimetres below the filtering disc. This lining is easily made by cutting a piece of filter-paper into a semicircle, the radius of which is slightly less than the diameter of the funnel at the top. Out of this semicircle a smaller one is cut, the radius of which is about 5 millimetres less than the diameter of the filtering disc. This leaves a half ring, which is placed in the funnel, taking care that the edges overlap slightly. When this lining has been placed properly in the funnel it should have water poured over it to make it adhere to the funnel. The filtering disc, with a piece of wet paper on it, is then dropped in the funnel, and the edges of the paper disc are pressed against the paper lining of the funnel. The apparatus is then ready for filtration.

It will be found convenient to cut a number of pieces of paper, for lining the funnel, at one time. A tin-plate model may be made of the proper shape and used to cut the pieces of paper.

The stem of the funnel may be connected with any usual form of aspirator, but I find I get all the pressure I

* *CHEMICAL NEWS*, vol. xxxii., pp. 46, 184; *American Chemist*, vol. v., p. 440, and vol. vi., p. 124.

need by using a straight tube of small diameter from one to three feet long. With such a tube filtration is always more rapid than with ordinary conical filters, and a much smaller volume of water is required for washing the precipitate, as all the water passes through the precipitate, while, with ordinary filters, most of it passes over the precipitate. This is not only a gain in time but a reduction in the amount of liquid.*

To connect the aspirating tube with the stem of the funnel, the best plan is to draw out the end of this stem, so as to reduce its size, and to widen the upper end of the aspirating tube sufficiently to admit the attenuated end of the stem. A rubber tube is placed over the joint. By making the connection in this way, not only is the liquid prevented from touching the rubber tube, but this further advantage is obtained, that the suction tube becomes filled as soon as any liquid runs through the filter. If this should not happen at once, a slight tap on the side of the tube will secure the desired effect.

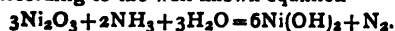
NOTE ON A NEW CATALYTIC REACTION.

By GEORGE WATSON, Jun., F.C.S.

THE writer, in the course of some preliminary experiments on the ammoniacal compounds of the metal nickel, observed a curious case of the decomposition of hydrogen dioxide (into water and oxygen), which evidently belongs to that class of reactions termed "catalytic."

An aqueous ammoniacal solution of nickel sulphate (NiSO_4) had been prepared, by adding excess of ammonium hydrate to a sulphurated, aqueous solution of that salt. The experiment, during the performance of which the reaction was observed, had for its object the ascertainment of answers to the following queries:—(a). If hydrogen dioxide be added to an ammoniated solution of a nickel salt, will the metal be oxidised into the state of per-salt, corresponding to the oxide Ni_2O_3 ? And (b), supposing this oxidation to be accomplished, does the nickel then exist in the form of an ammoniacal compound of the general formula $[\text{Ni}_2(\text{SO}_4)_{2x}](\text{NH}_3)_y + ?\text{Aq}$, obtainable by gradual acidification with dilute sulphuric acid and subsequent evaporation.

The result of the experiment was that, on adding the hydrogen dioxide to the solution, a brisk evolution occurred of a gas, which was found to consist of oxygen. A red-hot splinter of wood, on being plunged into the atmosphere of the test-tube, immediately burst into flame. Now, according to theory, one would be justified in expecting an evolution of nitrogen gas, for if nickel sesquioxide were momentarily formed, it, in the presence of ammonium hydrate, would be converted into nickel hydroxide and oxygen, which would immediately produce, in reaction with its equivalent of ammonia, nitrogen and water, according to the well-known equation—



But this reaction does not take place, and consequently we must conclude that nickel peroxide is not produced, even instantaneously. This is therefore a case, pure and simple, of the splitting-up of hydrogen dioxide, produced by the proximity merely of another substance, which itself is not changed in any degree, and is analogous to the reaction between finely divided metallic silver and hydrogen dioxide. The same reaction also occurs when the dioxide is added to a suspension of nickel hydroxide in watery

* There is an important advantage of rapid filtration, on which I have never seen any stress laid, that I remember. It is this: Most precipitates are soluble in water, although not appreciably soluble in the liquid in which precipitation takes place. When filtration is very slow, the water used for washing, in going through the precipitate, has time to dissolve an appreciable quantity of it, while, with rapid filtration, water passes through so quickly that it displaces the solution held by the precipitate, but has not time to dissolve an appreciable quantity. This, combined with more thorough washing, ensures greater accuracy.

solution of sodium hydrate, produced by adding the latter to a solution of nickel sulphate, and it may therefore be assumed it would also take place by using pure and dry nickel oxide (NiO) alone.

It may be added also that no effect is produced by using an acidified solution of nickel salt, or a solution of ammonium hydrate, individually. The hydrogen dioxide used was a commercial 20 volume preparation.

NOTICES OF BOOKS.

The Manual of Colours and Dye-Wares: their Properties, Applications, Valuation, Impurities, and Sophistications. For the Use of Dyers, Printers, Drysalters, Brokers, &c. Second Edition, revised and greatly enlarged. By J. W. SLATER. London: Crosby Lockwood and Co.

THE increased attention which is being given in this country to technological training and its appliances is very apparent in the department of the tinctorial arts. The work before us, which has now reached its second edition, has been so far extended and modified, in accordance with the vast changes which have occurred in the arts of dyeing, printing, &c., within the last few years, that it may be regarded as an independent treatise, and is consequently entitled to a somewhat closer examination than can be usually awarded to reprints. In the present, as in the former edition, the author takes up a strictly defined subject—a survey of the colours, mordants, alterants, and other drugs used in the tinctorial arts. These bodies, partly of natural and partly of artificial production, are now so numerous that a book of reference like the present is urgently needed. There are, or have been, it is supposed, some seven hundred colours in the market derived from coal-tar alone, and "the cry is still they come." In addition, are all the roots, barks, woods, fruits, and flowers used in the tinctorial arts. There are, therefore, few men, however wide their experience, who can retain in their memories the origin, uses, appearances, and possible impurities of such a number of substances. Hence a work like the present is urgently needed.

As regards the alterations and additions which have been made in the present edition, we find that certain oversights have been rectified, the descriptions of many substances formerly of great importance, but now almost superseded, have been abridged, and on the other hand a great number of new colours and other agents which have lately come into practical use are now duly noticed. We need scarcely wonder if a few omissions have here occurred, among which we may notice ethylene blue and "white paste." But upon the whole the newest resources of the dyer and printer are noticed with completeness, accuracy, and clearness.

On the subject of adulteration and other tricks of trade the author says little. He gives, indeed, very full descriptions of the appearance which natural dye-wares, &c., ought to present if sound and of good quality. He furnishes the simplest and most practical methods both for the detection of impurities and for ascertaining the comparative value of different samples. But he holds the opinion that the artificial colours "as obtained from dealers of repute, from their accredited agents, and from respectable drysalters," are generally free from impurities, whether intentionally added or derived from defective ways of working and imperfect purification. This is quite correct. The vulgar outcry that all aniline and other coal-tar colours contain arsenic has very little foundation in sober fact. Many of these colours do not involve in their manufacture the use of any arsenical materials at all: from others it is totally eliminated. Even magenta is now made without the use of either arsenic or mercury.

The author in his preface calls attention to the extraordinary confusion which prevails in the nomenclature of

dye-ware, both natural and artificial. Certain French and Belgian dyers have lately thought fit to give turmeric the wholly unnecessary and irrational name of "terra merita." The Americans have dubbed red-woods of good quality "hypernic," and an astringent extract of the Canadian hemlock tree "tamarac," which certain English dyers take to be a corruption of turmeric. But it is amongst the new artificial colours that the greatest want of a reformed nomenclature is felt. As the author remarks—"One and the same substance is sold under different names, and in return, bodies chemically and practically distinct are confounded under the same name." We have no hesitation in saying that for the smaller dyers who buy only small quantities at a time, and are often supplied by middle-men rather than by the makers or their representatives, this modern Babel is a greater evil than sophistication. The author has done no little to clear up this confusion by giving under each colour the names by which it is sometimes known. But he does not profess to have fully accomplished his object. Indeed to do this would be the work of a life-time: it would be necessary to go round the civilised world, obtaining from every maker and dealer samples of all his products, and then ascertaining by analysis and by practical tests which of these colours were identical and which distinct. Unfortunately, dyers will buy colours without learning the exact manner of their use, or even without knowing whether they belong to the "azo" or the phthaleine group, &c. The natural result is a reaction under the influence of which they mistrust all novelties.

A prominent feature of the book when it first appeared was the large proportion of strictly original matter it contained. This matter, as far as dye-ware are concerned which are still in general use, has been retained and, where practicable, improved. The articles on logwood, myrobalans, lac, and many others may be said to have become classical, having been very extensively copied into other publications and journals. Practical dyers, &c., were in general favourably impressed with the first edition, and will doubtless welcome the work in its improved form, the more as there is no other work in the language which covers precisely the same ground. To technological students preparing for examinations in dyeing and printing it will prove exceedingly useful.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 24, June 12, 1882.

Characters and Functions of the Double Salts formed by Fusion.—MM. Berthelot and Illosvay.—A thermo-chemical paper. The authors show that the double salts in question play an important part in a number of reactions and transformations effected in the dry way. Amongst others they mention the crystallisations of barium and strontium sulphate in the midst of their double sulphates. Barium carbonate crystallises also at the expense of the fusible double carbonates which enclose it.

Remarks on the Use of Zinc-Coke Elements in Electrolysis.—M. Berthelot.—A zinc-carbon element cannot be regarded as equivalent to a zinc-platinum element in the calculation of the quantities of heat developed by the reactions, which give rise to the voltaic current. The heat liberated by the attack of the zinc and the acid is not alone in the zinc-carbon element. The coke exerts, under these circumstances, peculiar and complicated reactions, absorbing hydrogen and oxygen, and

intervening both by its pure carbon and by the foreign matters incorporated in its mass.

Certain Explosive Alloys of Zinc and of the Platinum Metals.—H. Sainte-Claire Deville and H. Debray.—This investigation, as far as the osmides are concerned, was nearly completed before the death of Sainte-Claire Deville, and has since been concluded by M. Debray. Osmium is the only one of the platinum metals which does not retain zinc when its alloy with a large excess of zinc is treated with an acid capable of dissolving this metal. The others retain obstinately about 10 to 12 per cent, and the metals insoluble in *aqua regia* (rhodium, iridium, and ruthenium), remain in the state of peculiar products, without metallic lustre, which seem to be an allotropic modification of the true alloys. It is impossible to comminute the osmides by mechanical action. A triple alloy of osmium, iridium, and zinc, if heated to about 300°, takes fire suddenly, almost with explosion, diffusing fumes of zinc and of osmic acid.

The Law according to which the Electromotive Force of a Magneto-Electric Machine varies as a Function of the Resistance of the Exterior Circuit.—Marcel Deprez.—The author has been struck with the fact that the electromotive force developed in the ring of dynamo-electric machines not only does not increase infinitely with the intensity of the currents which traverse the inducing electro-magnets, but finally diminishes very notably when the current produced increases more and more. Hence he has been led to think that the electromotive force developed in the ring of a magneto-electric machine, of which the magnetic field is constituted by a permanent magnet, is not constant, as has always been admitted hitherto, but is a function of the intensity of the current itself developed in the ring. In proportion as the intensity of the current traversing the ring increases, the wires of the ring cut the lines of force of the magnetic field comprised between the polar pieces and the ring at an angle differing more and more from a right angle, which is the angle corresponding to the maximum electromotive force. The only means of minimising within certain limits the defect inherent in dynamo-electric machines, consists in the use of very powerful inducers, surrounded with a moderate quantity of wire and of brushes capable of adjustment.

Oscillations of the Plane of Polarisation by the Discharge of a Battery. Simultaneity of Electric and Optic Phenomena.—E. Bichat and R. Blondlot.—Between a polariser and an extinction analyser a transparent body is placed in a coil of long and fine wire, which is connected with the inner and outer coatings of a battery. In the circuit there is introduced a universal discharger which permits the discharge to be produced when the difference of potential is sufficient. At the moment of each discharge the eye placed before the analyser detects a bright re-appearance of light, which shows that the plane of polarisation has been deflected.

Decomposition of Salts by Matters in Fusion.—A. Ditté.—The decomposition of calcium phosphates by matters in fusion is effected like the splitting up of salts by water or by other bodies liquid at ordinary temperatures, and it gives rise to equilibria quite of the same order. These properties belong also to analogous compounds, containing, in place of phosphorus, arsenic or vanadium.

Mechanism of Putrid Fermentation and the Resulting Alkaloids.—A. Gautier and A. Etard.—Putrid fermentation breaks up the albumenoid molecule by a process of simple hydration. It is resolved under the influence of bacteria into two principal parts; the one, A, relatively stable, which forms the nucleus to which M. Schützenberger has given the general formula—



whence are derived the gluco-proteines, and subsequently the leucines. The other portion, B, unstable, is resolved

into ammonia and carbonic acid, and into ammonia and the formic, acetic, and oxalic acids. The existence of indol and the pyridic and hydro-pyridic bases among the products derived from the albumenoids by putrefactive hydration compels us to admit for several of the radicles of the proteic molecule the connections of nitrogen and carbon, which characterise the homologous series of C_2NH_3 and of C_3NH_7 .

Action of Heat upon a Solution of Acid Nickel Sulphate in Presence of Sulphuretted Hydrogen.—H. Baubigny. The author concludes that both for acid and neutral solutions, when the respective proportion of the weights of the acid and the metal remain constant, the precipitation of nickel is so much the more complete as the solution is more dilute. Whatever may be the proportion of the two volumes, liquid and gaseous, the precipitation increases with time.

The Decomposing Action which Certain Organic Matters Exert upon Oxygenated Water, with Reference to a Memoir by MM. Paul Bert and P. Regnard.—M. Béchamp.—The author proposes the law that whilst organised matter, the organs, or organic tissues, can disengage the oxygen of hydrogen peroxide, the proximate principles isolated from them do not possess this property.

Zeitschrift für Analytische Chemie.
Vol. xx., Part 4.

Determination of the Permeability of Soils and Building Materials.—H. Fleck.—The author rejects the aspiration process. He presses air through the soils introduced into a cylinder and made to settle as compactly as possible by tapping the sides. He finds that the times in which equal quantities of air stream out, the height of the strata of soil being equal, are inversely proportional to the height of the manometer. For equal speeds of equal quantities of air the resistances are directly proportional to the strata of soil.

Detection of Magnesia in Limestone.—M. Pichard.—Magnesia is quickly detected by its alkaline reaction. If the pulverised stone does not at once react upon red litmus paper, a portion is heated on platinum foil at the spirit-lamp to a temperature below dull redness. Pure limestone (calc-spar) remains unchanged, but if 1-1000th magnesia is present an alkaline reaction appears. The natural magnesium silicates have an alkaline reaction, whilst those of aluminium, potassium, sodium, and calcium are perfectly neutral.

Technical Examination of Glasses.—Max Müller.—The author applies the known blowpipe reactions. Lead in glass or enamel is detected by heating for a minute or two a bead of the sample fused to the end of a small glass rod. Glass free from lead shows no change. Specimens containing much lead blacken and the bead becomes opaque. Green cuprififerous glass, if heated in the reduction-flame, is coloured in parts an intense purple-red. The simultaneous presence of lead masks this reaction. If a fragment which is to be tested for copper or gold is heated in a glass tube, and if both are drawn out a little while soft, the colour due to gold remains unchanged, whilst red copper-glass becomes perfectly colourless.

Determination of Sodium Ferrocyanide in Soda.—G. Lunge.—The author proposes to treat the lye with carbonic acid in order to precipitate the iron combined with sodium sulphide, to filter, evaporate to dryness, ignite strongly, and determine the ferric oxide in the residue.

Commercial Examination of Tallow at Paris.—The sample is first dissolved in chloroform, when gelatinous matters, fragments of skins, calcium phosphate of lime, and other non-fatty matters remain undissolved. The French stearine makers take 44° as the lowest permissible melting-point for tallow. In order to determine oleine

and stearine portions are saponified, the soda-soap is decomposed with sulphuric acid, and the fatty acids set free are examined for their point of congelation.

Vol. xxi., Part 1, 1882.

Determination of the Ammonia capable of being Split off from the Amides in the Extracts of Plants.—E. Schulze.—An extensive reply to A. Morgen's criticism on the author's method of determining such ammonia (*Zeitschrift für Anal. Chemie*, xx., p. 37).

Studies on Argentous Oxide.—Dr. W. Pillitz.—The author shows that this supposed compound, Ag_2O , is a variable mixture of metallic silver, metallic antimony, and silver oxide.

Contributions to the Analysis of Wine.—Dr. J. Nessler and Dr. M. Barth.—The authors communicate the results of their experience on the determination of extractive matter in wine; on a modification of Neubauer's test for glucose (potato-sugar) in wines, and on the optical behaviour of pure and of sweetened wines; on the detection of free tartaric acid in wines, and on the determination of citric acid in wines. Some of these processes we shall notice at length.

Volumetric Determination of Nitrogen.—A. Bernthsen.—Already noticed.

Contributions to the Chemistry of Tobacco.—R. Kissling.—The author treats in this memoir on the determination of nicotine. He criticises the processes of Henry and Boutron-Charlard, of Schlösing, Wittstein, Kosutany, Dragendorff, Nessler, and Liecke, and proposes then the following method:—The tobacco, if in the unmanufactured state, is first freed from ribs, cut up, dried for one to two hours at 50° to 60° , and lastly reduced to a coarse but uniform powder; 20 grms. of this powder are carefully saturated with 10 c.c. of a dilute alcoholic solution of soda (6 grms. of caustic soda dissolved in 40 c.c. of water and mixed with 60 c.c. of alcohol at 95 per cent). This operation is performed with a pestle and spatula in a roomy porcelain capsule. The tobacco, which is then in the state of a moderately moist but not coherent powder, is put in a suitable packet of filter-paper and extracted with ether. For this purpose a simple extraction-tube is most suitable, as proposed by Tollens. Its wider part, connected with the reflux condenser, must be 35 c.m. in length, and the flask containing about 100 c.c. of ether must be large enough to hold 400 c.c. The paper packet is best made by coiling a slip of filter-paper, 25 to 30 c.m. in length and 10 c.m. in breadth, upon a piece of glass tube 2 c.m. in outside diameter, closing the paper tube at one end, and then introducing it into a second and longer glass tube, of such a length that some difficulty is felt in sliding it up and down. After drawing out the inner glass tube the paper is easily filled. Care must be taken that the tobacco lies everywhere equally compact and not too loose, so that no channels may be formed during extraction. This is easily effected by filling in the tobacco gradually, and frequently tapping the side of the tube. The top of the packet is finally depressed a little, and the apparatus is so fixed that the condensed ether may drop into this depression. In two or, at most, three hours the tobacco is exhausted. The ether is then cautiously distilled off, but not completely; the residue is mixed with 50 c.c. of a very dilute solution of soda (4 parts caustic soda in 1000 of water), and submitted to distillation in a current of steam. To prevent any portion of the liquid being carried over by spiriting, the inner end of the exit-tube is surrounded with a double cage of wire gauze, fixed so as not to touch the end of the tube. The distillation is conducted energetically, and so that at the end only about 25 c.c. of liquid may remain in the flask. To prevent frothing over, the steam should not be introduced until the liquid has been boiling for a few minutes. Each 100 c.c. of the distillate should be collected separately, and titrated with sulphuric acid, using

rosolic acid as indicator. Only in case of very strong tobaccos it is needful to distil off more than 400 c.c.

Determination of Sulphur in Pyrites.—F. Boeckmann.—Already noticed.

Crystal Analysis.—O. Lehmann.—The author describes a microscope well adapted for observing the growth of crystals.

Spectral Analysis of Phosphorescent Light.—W. Crookes.—From the *CHEMICAL NEWS*.

Electric Conductivity as a Means of Ascertaining the Purity of Oils and Tissues.—L. Palmieri.—The author has observed that the electric conductivity of the oils is notably different. By means of a special bifilar electrometer, which he calls a diagometer, he utilises this principle for the examination of commercial oils.

Determination of the Difference of the Specific Gravities of Two Liquids.—W. Dittmar.—From the *CHEMICAL NEWS*.

Determination of Ash in Flour.—C. Weigelt.—Ten grms. of the sample are carbonised in a spacious platinum capsule, which is readily effected in less than ten minutes. The charred mass is then broken up with a platinum spatula into fragments the size of a pea, and transferred to a middle-sized platinum crucible. If any carbon adheres to the sides of the capsule it is easily incinerated, and may then be added to the bulk. Over the open crucible is turned a cylinder of mica, wide enough to leave an interval of 2 to 3 m.m. between its inside and the outside of the crucible, about half the height of which is within the cylinder. A common Bunsen burner effects the complete incineration of the carbon in six to eight hours at a low red heat.

Apparatus for Collecting and Measuring Nitrogen in its Volumetric Determination.—Paul Jeserich.—This apparatus does not differ from that described some time ago by Hugo Schiff.

Steam Apparatus Combined with Körting's Steam-jet Blast.—W. Thörner.

Small Steam-jet Blast for Laboratory Purposes.—W. Thörner.

Determination of the Vapour-Tension of Substances easily Volatilised.—W. Thörner.

An Extraction-Apparatus.—E. Thorn.

A Gas Lamp for the Production of High Temperatures.—R. Muencke.—These memoirs require the accompanying illustrations.

Closing-Fluid in Orsat's Apparatus for the Analysis of Smoke Gases.—M. Hagemann.—The author recommends mercury in preference to water, which latter may allow of errors as high as 2 per cent.

Indicators for Alkalimetry and Acidimetry.—The compiler mentions nitrophenol, proposed by H. W. Langbeck in the *CHEMICAL NEWS*; phenacetoline, recommended by Paul Degerer; tetra-hydro-ellagic acid, suggested by J. Oser and W. Kalmann; phenol-phthaleine and tropeoline.

Development of Sulphuretted Hydrogen.—P. Casamajor.—From the *CHEMICAL NEWS*.

Absorption-Spectra of the Non-Metals and their Compounds.—C. Gänge.—The particulars are not given.

Detection of Ozone.—R. Böttger.—Paper saturated with perfectly neutral gold chloride is coloured violet by ozone, and is said not to be affected by nitrous acid.

The Determination of Caustic Alkalies in Presence of Alkaline Carbonates and Sulphides.—E. A. Grete.—From *Liebig's Annalen*.

Sodium Tungstate as a Reagent for Baryta.—Contrary to the statements of Anthon and Sonstadt not only neutral and ammoniacal solutions of baryta and lime, but those of baryta, are precipitated by this reagent. If the solution is strongly acidified with acetic acid, baryta

alone is thrown down by sodium tungstate, while lime and magnesia remain in solution.

Behaviour of Dolomite with Acetic Acid.—K. Haushofer.—The constituents of dolomite are dissolved even at low temperatures by acetic acid, whether dilute or concentrated, in such proportions that an approximate separation of dolomite from calcite in this manner becomes impossible.

The Reducing Action of Potassium-Ferrous Oxalate.—J. M. Eder.—This reductive agent is effective, not merely in alkaline and neutral, but in acid solutions. It completely reduces platinum chloride and platinum potassio-chloride to the metallic state. Silver chloride, iodide, and bromide are reduced slowly in the cold, but quickly if heated, as is also mercuric chloride. Prussian blue, when recently precipitated, is instantly reduced.

Method for the Quantitative Determination of Ferrous Oxide along with Ferric Oxide in Presence of Organic Acids and Cane-Sugar.—J. M. Eder.—The solution, which must not be strongly acid, is mixed with an excess of neutral potassium oxalate and silver nitrate. After a few minutes, tartaric acid is added in sufficient quantity to prevent the precipitation of ferric oxide, and the liquid is then supersaturated with ammonia. The presence of ammonium chloride promotes the coagulation of the precipitate, which is then washed with water containing ammonium chloride and ammonia. From the quantity of silver obtained the ferrous oxide is calculated. Direct sunlight must be avoided, and the beakers, &c., may be coated with black paper. The process is only applicable in the absence of those organic bodies which are able to reduce silver salts in the cold.

Volumetric Determination of Ferrous Oxide in Hydrochloric Solution by Potassium Permanganate.—C. Zimmermann.—The presence of a manganous salt entirely removes the perturbing action of the hydrochloric acid. The author employs a solution of manganous sulphate containing about 200 grms. per litre. The addition of 20 c.c. of this solution enables us to obtain results which not only agree among themselves, but with the figures obtained by titration in a sulphuric solution and by the gravimetric process.

Direct Determination of Alumina in Presence of Ferric Oxide.—E. Donath.—The solution of alumina and ferric oxide, which should not exceed 100 c.c., is mixed with ammonia until the free acid is chiefly neutralised. He then adds a concentrated solution of hyposulphite to reduce the ferric oxide to the ferrous condition. The solution thus prepared is slowly poured into a boiling ammoniacal solution of potassium cyanide, the volume of which is at least double that of the solution of alumina and iron. The clear greenish yellow liquid thus obtained, after being heated for a short time, is cooled quickly and completely by setting the beaker in cold water, and is then acidified with hydrochloric acid. The alumina is then precipitated with ammonium carbonate; the precipitate is allowed to settle, collected on a filter, and washed with boiling water. The alumina appears nearly white if the proportion of iron is relatively small, and if the separation of iron cyanides has been avoided by working expeditiously. If the precipitate has a dirty yellowish colour it is digested along with the filter in dilute hydrochloric acid (1:4). The iron cyanides remain insoluble, whilst the alumina is dissolved, and is reprecipitated from the filtrate in the known manner.

Solubility of Prussian Blue and Turnbull's Blue.—W. Gintl.—The recent precipitates dissolve in a moderate excess of acid at a gentle heat, and in larger quantities in the cold. The faintly yellow solutions are precipitated by water. The author thinks it not improbable that Prussian blue and Turnbull's blue are identical.

Separation of Nickel and Cobalt.—G. Delvaux.—Already inserted under *Comptes Rendus* (xcii., p. 723).

Solubility of Mercurous Chloride in Mercuric Nitrate.—E. Drechsel.—Calomel in a solution of mercuric nitrate dissolves with gentle heat, forming mercuric chloride and mercurous nitrate.

Separation of Silver from Lead.—E. Donath.—The nitric solution of the two metals is mixed in a beaker, or a large porcelain crucible, with 4 to 5 c.c. of pure glycerine, supersaturated with ammonia, and mixed with 10 to 15 c.c. of concentrated soda-lye. The clear liquid thus obtained is heated, and boiled for three to five minutes; the formation of a silver deposit on the sides is prevented by stirring with a glass rod. When cold the reduced silver is filtered off, washed with boiling water, with warm dilute acetic acid, and again with hot water. The acetic acid in the filtrate is neutralised, and the lead thrown down with sulphuretted hydrogen. The separation of silver from lead is also practicable in presence of copper and bismuth, as the oxides of these metals are also soluble in glyceric alkalies.

Determination of Copper.—E. A. Grete.—The author titrates with potassium xanthogenate, a method already proposed by Schwarz.

Norwegium.—Tellef Dahll.—Already noticed.

Separation of Tungsten from Antimony, Arsenic, and Iron.—A. Cobenzl.—The finely-powdered substance is digested for five to six days with strong nitric acid, occasionally adding hydrochloric acid. The solution, together with the yellow tungstic acid, is placed in a capsule and evaporated to dryness on the water-bath. The residue is dissolved in very dilute nitric acid and again evaporated to dryness, the operation being repeated three times. The final residue is treated on the boiling-water-bath with very dilute nitric acid and a little tartaric acid, filtered, and the residue of tungstic acid and insoluble silicates and silica is washed with boiling-water slightly soured with nitric acid. The tungstic acid is easily separated from the silicates and the silica by treatment with very dilute ammonia. The ammoniacal solution when evaporated down and ignited yields pure tungstic acid. Arsenic, antimony, and iron are determined by known methods in the filtrate free from tungsten.

Separation of Tin from Arsenic and Antimony.—F. W. Clarke.—This paper consists of unfavourable criticisms upon Clarke's method.

The Electrolytic Determination of Metals.—An illustrated memoir.

Volumetric Determination of Fluorine.—S. Penfield.—From the *American Chemical Journal*.

Determination of Sulphur in Carboniferous Substances.—A. Kollert.—The sample is heated to redness in a porcelain tube 25 m.m. in width in a gaseous current consisting of 3 volumes of hydrogen and 1 volume carbonic acid. The sulphur is quickly converted into sulphuretted hydrogen without any oxidation. The gas thus obtained is passed first into a flask and then into a solution of silver nitrate faintly acidified with nitric acid. Phosphorus and arsenic do not interfere even when present in large quantity.

Precipitation of Ammonium Phospho-molybdate in Presence of the Salts of Organic Acids.—J. W. Mallet.—From the *American Chemical Journal*.

A Reaction of Tartaric Acid.—H. J. H. Fenton.—From the *CHEMICAL NEWS*.

Detection of Chloral Hydrate.—F. Ogston.—Yellow ammonium sulphide gives with moderately concentrated solutions of chloral hydrate an orange colouration gradually passing into brown on prolonged standing. Finally an orange-coloured precipitate appears. Butyl and so-called chroton-chloral give the same reaction.

Behaviour of Arsenic Acid with Sugar.—A solution of sugar mixed with a solution of free arsenic acid and let stand for some hours takes a rose colour, which passes into a more purple red. Lactose, grape sugar, and man-

nite give the same reaction, whilst starch, gum, and the sugar of liquorice are inert. Arseniates and arsenious acid do not produce the reaction.

The Compounds of Starch and Dextrine with Free Iodine.—S. U. Pickering.—From the *CHEMICAL NEWS*.

Determination of the Vapour Density in the Barometer Tube.—Ch. A. Bell and F. L. Tud.—From the *Journal of the Chemical Society*.

Determination of Actual Glycerine in Aqueous Solutions.—Two methods are described, that of Morawski (*Journal für Prakt. Chemie*), and that of Muter (*Analyst*). The compiler considers the latter very satisfactory.

Reduction of Alkaline Solutions of Copper Oxide by Non-Saccharine Matter.—J. H. Tucker.—From the *CHEMICAL NEWS*.

Volumetric Determination of Tartaric, Malic, and Citric Acid.—F. W. Clarke.—The author in a preliminary communication proposes to titrate with potassium permanganate as in the case of oxalic acid.

Determination of the Temporary Hardness of a Water.—V. Wartha.—Already noticed.

Determination of Carbon in Water.—A. Dupré and H. W. Hake.—From the *Journal of the Chemical Society*.

MISCELLANEOUS.

A Warning.—Chemists are warned against an impostor who falsely represents himself to be a brother of Dr. Emerson Reynolds, F.R.S., of Dublin University. He nominally seeks employment, but instances have occurred in which he has succeeded in obtaining money.

University College, Bristol.—We have great pleasure in bringing before our readers an earnest appeal made by Professor Silvanus P. Thompson on behalf of the physical laboratory of this Institution, which is at present unprovided with the apparatus for conducting exact experiment and original research. As we are informed, many of "the precise modern appliances of optical, acoustical, magnetic, and electric science are conspicuous by their absence." Students are not wanting, sufficient room is being provided and will be rendered available in the course of the present year. We need scarcely add that in Mr. Thompson the physical department possesses a most able, learned, and zealous professor. But all these advantages are for the present nullified by the want of the necessary apparatus. Under these circumstances Professor Thompson is endeavouring to raise a fund of £1000 to furnish the most essential requisites for the physical laboratory. We cordially second his appeal, and we trust that the friends of scientific education will not allow the University College of Bristol to remain so far behind kindred institutions in Manchester, Leeds, Liverpool, Birmingham, and Nottingham. We may add that since this effort was begun by Professor Thompson several very valuable contributions have been promised, but that further contributions or donations of apparatus would be most thankfully received.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Magnesia-Alum.—Is the native magnesia-alum (Pickeringite) employed as a raw material in any chemical industry; that is to say, has it a commercial value, and for what purpose?—J. L. W.

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(Similar to, but containing Less Iron than.
BAUXITE).

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Silica, &c.	...	...	...	4'50 "	19'24 "	34'35 "
Water of combination	...	...	...	30'00 "	27'13 "	20'52 "
				100'00	100'03	100'09

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REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.

By J. W. MALLET, F.R.S.,

Professor of Chemistry in the University of Virginia.

(Continued from vol. xlv., p. 283.)

Second Series of Experiments.

Preparation and Purification of Aluminum Bromide.—Aluminum bromide was prepared by the action of liquid bromine upon metallic aluminum of commerce, and was afterwards carefully purified. The first action is so violent that without special precaution the process involves some danger. In a first attempt a lump of aluminum weighing 15 to 20 grms. was dropped into a long-necked flask containing a considerable quantity of bromine. There was little action for a few moments, but as soon as it began vivid combustion took place, torrents of bromine vapour were driven forth, and after the flask had cooled the surplus metal was found to have been completely fused and had nearly melted its way through the glass.

By the following arrangement the bromide was prepared in large quantity and without any trouble. About 50 c.c. of bromine was placed in a large untubulated retort of hard Bohemian glass, the neck of the vessel standing vertically upwards, and an elongated piece of ingot aluminum, the upper end of which was firmly tied with aluminum wire to a glass rod, was cautiously dipped into the liquid and withdrawn as soon as violent action began. By alternately lowering and raising the glass rod the lower end of the metal was immersed in the bromine at intervals short enough to keep up the temperature of the latter and make the action practically continuous, while there was no actual ignition, and but little bromine vapour was lost. As soon as a considerable portion of this bromine had become converted into aluminum bromide the further action became manageable. The remainder of the main quantity of metal to be treated was now at once added in lumps of 10 to 20 grms. each; a long tube funnel with a glass stop-cock near the upper end was introduced into the neck of the retort, and liquid bromine was allowed to drip in at just such a rate as to keep up steady but not inconveniently violent action, taking care to keep the metal always covered. When the pieces of metal had nearly disappeared the supply of bromine was stopped, about 30 grms. more of aluminum was added in filings, the contents of the retort were digested for four hours at about 230° C., and the fluid portion was then decanted off from the insoluble residue into another (tubulated) retort. Most of the silicon was left undissolved as a brown amorphous powder. Most of the iron was converted into ferric bromide, which, during the continued heating, was in part broken up, leaving ferrous bromide instead. A little copper derived from one sample only of the aluminum used, was of course converted into bromide also.

More than a kilogramme of crude aluminum bromide being thus prepared, it was purified by repeated fractional distillations at carefully regulated temperature, using as a receiver in each case the retort to be next employed, and adding each time, except the last, a few grammes of aluminum filings. About a sixth of the whole amount was each time first distilled off and rejected as liable to contain silicon bromide, a little of this compound actually occurring in the earlier distillations; and another sixth was left behind, in order to retain the iron, which was separated with greater difficulty. After five distillations the bromide was obtained perfectly colourless, and boiling steadily

at 263.3° C. under 747 m.m. pressure. Specimens were dissolved in water, and carefully examined for iron, silicon, copper, and other conceivable impurities, but none could be found. As an additional precaution, the last distillation was effected in a slow stream of pure nitrogen, so as to avoid any formation of oxide or oxy-bromide of aluminum, the propriety of this being suggested by Berthelot's recent results* as to the thermic relations of aluminum to oxygen and the haloids, and the distillate was collected in three successive portions, the results of whose analysis will be separately given further on; they go to show that these three portions were sensibly identical. The individual specimens of pure bromide required were collected in little tubes of thin hard glass, previously closed in at one end, carefully dried, and sealed at the other as soon as the tube was nearly filled, the fused bromide having been introduced through a miniature tube funnel to avoid smearing the upper end of the collecting tube, and a new, perfectly dry funnel used each time. The weight of each collecting tube had been taken beforehand, and the piece of glass drawn off in sealing being washed, dried, and weighed, the weight of the sealed tube itself was known, the difference between this and the total weight of tube and contents giving the amount of bromide.

Experiments to determine the amount of bromide in this compound by precipitation with a silver solution have the advantage over those of Dumas, above quoted, upon the chloride that, as Stas has shown,† silver bromide practically does not share with the chloride of this metal the slight solubility in the exactly neutralised liquid from which precipitation has been effected which renders difficult an exact determination of the amount of silver needed. Pursuing in general the course so carefully examined by Stas, the following were the details of the method employed.

Preparation of Pure Metallic Silver.—Pure metallic silver was prepared by dissolving in nitric acid nearly pure silver already on hand, diluting largely, precipitating with pure hydrochloric acid, digesting the precipitate with aqua regia, washing thoroughly, and reducing the purified chloride in the liquid way with sodium hydrate (from metallic sodium) and invert-sugar (from perfectly pure and well crystallised cane-sugar boiled with dilute hydrochloric acid). The metal, after having been carefully tested, was fused by a jet of purified hydrogen mixed with rather less oxygen than necessary for perfect combustion. To avoid the necessity for any cutting up afterwards with steel tools, the pulverulent metal was divided into a number of little lots of various weight, and these were supported upon the surface of little blocks made by compressing pure sugar charcoal (from cane-sugar quite free from heavy metals) made into a paste with pure cane-sugar syrup and gradually drying and heating to redness‡. The fused silver thus obtained was examined for occluded oxygen, following the method of Dumas§ in his recent experiments. It was supported upon a thin layer of pure lime in a hard glass tube, and heated to moderate redness in a Sprengel vacuum. The amount of oxygen given off was less than that obtained by Dumas, doubtless owing to the fact that his silver was fused under nitre and borax, while mine was, as just stated, melted on a surface of carbon with no flux. He obtained at the rate of 57 c.c. of oxygen (for 0° C. and 766 m.m.) per kilogramme of silver, and in other experiments, prolonging notably the time of fusion, as much as 158 c.c. and 174 c.c. I obtained but 34.63 c.c. per kilogramme, and in another experiment made by Mr. Santos, then a student in this Laboratory, the silver having been fused upon ordinary wood charcoal, but 30.12 c.c. was given off. All the silver used in the

* Bulletin de la Société Chimique de Paris, 20 Mars, 1879, p. 265.
† Comptes Rendus, 73, 931. Annales de Chimie et de Physique, (5), 3, 289.

‡ This form of support had the advantage that if any particles of carbon should be mechanically enclosed in the silver they would be readily seen on solution of the latter in nitric acid.

§ Comptes Rendus, 86, 65. Chem. Centralblatt, 27 Feb., 1878, S. 138.

atomic weight determinations was, in separate portions, heated in the Sprengel vacuum as long as any gas was expelled, and, having been treated with pure hydrochloric acid to remove any possibly adhering particles of lime, the granules were finally washed with pure water, dried, and kept for use in a glass stoppered bottle. An approximate calculation having been made of the quantity of silver which would be required to precipitate each of the specimens of aluminum bromide, an amount less than this by something under a decigramme was dissolved in nitric acid in a strong flask closed with a stopper, which was carefully opened when cold, and the contents were somewhat further diluted with water. The amount of specially purified nitric acid used was apportioned so as to leave the smallest possible excess after solution of the metal.

Precipitation of Silver Bromide—Details of Method used.—To avoid the danger of losing aluminum bromide when it was brought in contact with water, the action being quite violent and attended with dispersion of white fumes, each one of the sealed thin glass tubes containing the bromide was, when the time came for using it, cautiously marked with transverse scratches at intervals of about half-an-inch by means of a writing-diamond, and a strong glass bottle with a very well ground stopper having had a sufficient quantity of pure water placed at the bottom, the tube was broken across at the uppermost scratch, above the surface of the bromide, the empty point was dropped into the bottle, and the rest of the tube carefully lowered by means of a loose fitting spiral of platinum wire held sideways, so as to rest by the closed end on the bottom of the bottle without allowing the water to reach the bromide until the stopper had been inserted and tied down. By now gently inclining the bottle the water was brought very gradually into contact with the aluminum bromide, without dangerously violent action and without possibility of loss.

As soon as solution was complete and the bottle had cooled down, the stopper was removed, any liquid adhering to it washed back into the bottle, and a stout glass rod with square end was used to gently crush the tube to small fragments, as otherwise its contents could not have been brought fairly into contact with the silver solution, since the interior of the tube would have become plugged up with silver bromide. The scratches previously made upon the glass rendered it easy to break it up without any splashing, and the rod was then well washed with pure water allowed to run directly into the bottle. The silver nitrate solution destined for this particular specimen was now washed out of the flask in which it had been shortly before prepared into the bottle containing the bromide, the stopper was again inserted, and the bottle was vigorously shaken as in the usual Gay-Lussac silver assay. The precipitation of the bromide was completed with a very carefully adjusted solution of silver nitrate, containing 1 milligramme of silver per cubic centimetre, and delivered from a burette* reading clearly to $\frac{1}{10}$ th c.c. The correspondence in capacity of the burette and measuring flask used was well ascertained. It was at first intended to use, for some at least of the experiments, an excess of silver, filter off the silver bromide formed, and determine silver in the filtrate by Volhard's method† with a standard solution of sulpho-cyanate; but this plan was abandoned as less simple, and probably requiring further investigation in regard to inherent sources of error and limits of accuracy. The completion of the reaction was therefore ascertained simply by very cautious addition of the standard silver solution until all trace of turbidity ceased, verifying the result by counter test with a drop of very dilute solution of potassium bromide. By letting the bottle stand for a little while after each addition of silver

solution and shaking, and then tilting it to one side so as to bring the upper portion of the liquid above the line it had before occupied on the glass, letting the new drop fall gently in, an exceedingly slight cloud was easily seen.

It should be added that the silver globules and the tubes of aluminum bromide, after final cleansing and drying, were handled only with forceps, so as to avoid any risk of traces of chlorides being taken up from the fingers, and due attention was given to the freedom of the laboratory atmosphere from hydrochloric acid or chlorine in other volatile forms.

Direct Results of Second Series of Experiments.—The results of the experiments made in this way were—

A.—Aluminum bromide from first portion of last distillate.

AlBr ₃	Ag for Precipitation.
I.—6.0024 grms. required	7.2793 grms.
II.—8.6492 " "	10.4897 "
III.—3.1808 " "	3.8573 "

B.—Aluminum bromide from second portion of last distillate.

IV.—6.9617 grms. required	8.4429 grms.
V.—11.2041 " "	13.5897 "
VI.—3.7621 " "	4.5624 "
VII.—5.2842 " "	6.4085 "
VIII.—9.7338 " "	11.8047 "

C.—Aluminum bromide from third portion of last distillate.

IX.—9.3515 grms. required	11.3424 grms.
X.—4.4426 " "	5.3877 "
XI.—5.2750 " "	6.3975 "

(To be continued.)

NOTE ON DIDYMIUM.

By B. BRAUNER.

In the *Comptes Rendus* (xciv., p. 1528, June 5, 1882; see *CHEMICAL NEWS*, vol. xlv., p. 273), M. Clève published a note on a new metal from cerite, which he calls Diβ. This metal is less basic than lanthanum, but more so than didymium.

In a paper read before the Imperial Academy of Vienna on October 6, 1881, I have treated the same subject, but I have postponed the publication of the part concerning the new element of cerite until my experiments should be more advanced (see *Anzeiger der Kaiserl. Akademie der Wissenschaften*, of October 6, 1881, and of June 9, 1882).

The communication made by M. Clève permits me now to lay before the Academy the first results of my experiments, with which I was engaged for three years.

I found that the sulphate of lanthanum, purified by repeated crystallisations, can be split up into two earths on treating the oxide by a solution of ammonium nitrate. The atomic weight of the more basic (oxide of lanthanum) is 138.3 to 138.8, and that of the less basic about 140.2.

On treating didymium oxide which did not contain any lanthanum by ammonium nitrate, I could extract an earth which forms colourless salts, and the atomic weight of which was 140.6. The atomic weight of the remaining didymium was 142.5; but after repeated fractional precipitations a product was obtained at last having an atomic weight of 146.6.

In the spark spectrum of different fractions obtained on decomposing impure didymia I found lines, not belonging to any earth found in cerite, the spectra of which are known up to the present time.

I explained all these phenomena by the presence of a fourth element in cerite, which is, no doubt, identical with M. Clève's Diβ.

* This burette was simply drawn down to proper bore at the bottom, and the flow of the liquid was regulated by the admission of air through a well-ground stop-cock at the top.

† Fresenius's *Zeitschrift für Analyt. Chemie*, 18ter Jahrg., 2tes u. 3tes Heft., S. 271.

On purifying carefully new quantities of didymium, and especially on removing the more basic and the less basic fractions than didymium, I found for the atomic weight of didymium the number $Di = 145.4$ ($O = 16$, $S = 32.074$).

Using the same process for the purification of didymium, which gave formerly the atomic weight 146.6 , I succeeded in separating another earth with a higher atomic weight than 154 : the portion remaining after this purification gave a didymium of an atomic weight of 145.4 . I consider this number as coming nearest of all to the true atomic weight of this element.

The more basic liquids obtained after the precipitation of pure didymia (which liquids were free from lanthanum) contained a mixture of didymium with an earth, which lowered the atomic weight of didymium as far as 143.3 .

It is seen from the above experiments that the ordinary didymium is a mixture of at least three elements. The one is true didymium ($Di = 145.4$), the other ($Di\beta$ of Clève) is more basic than didymium, and its atomic weight is about 141 ; the third, with a higher atomic weight, is less basic than didymium (probably samarium).

The object of the above communication is not to discuss priority with the Swedish investigator, whose beautiful researches on the rare earths mark a new epoch in Science; I only intend to show that I have made observations on a new earth in cerite, independently of M. Clève.

The observations were made in Professor Roscoe's laboratory.—*Comptes Rendus*, xciv., p. 1718-19, June 26, 1882.)

ACTION OF SULPHURETTED HYDROGEN UPON NICKEL SULPHATE IN ACETIC SOLUTION.

By M. H. BAUBIGNY.

If we add acetic acid to an aqueous solution of neutral nickel sulphate, which is then saturated with sulphuretted hydrogen at 0° , and left in a closed vessel at the ordinary temperature, the action of the sulphuretted hydrogen upon the nickel sulphate is retarded, and may even be annulled.

Thus in a solution containing 0.200 grm. neutral sulphate to 140 c.c. of liquid acidulated with 3 grms. acetic acid, after standing for twenty-four hours between 12° and 16° , the sulphuretted hydrogen had not determined any precipitate. Not until some days later there appeared on the side of the vessel some very fine black grains, which increased very slowly, and became the origin of a crystalline conglomerate. The mixture was left thus for ten months, exposed to variations of temperature from 6° to 34° , but the precipitation was still incomplete, and the liquid retained 0.005 grm. nickel sulphate. But a neutral solution of nickel sulphate made of the same proportions of sulphate and water and saturated with sulphuretted hydrogen, after a month's exposure to the temperature of the atmosphere, contained merely a weight of sulphate lower than 0.001 grm. The action of the acetic acid is thus manifest. It may be even reduced one-half, that is, to 1 per cent with reference to the water without the precipitate appearing at the end of twenty-four hours, other conditions remaining the same. If the concentration of the metallic solution is increased the results change.

If we operate with a solution containing for the same volume of liquid 140 c.c., and acidulated to 1 per cent with acetic acid a weight of 1.1 grm. neutral nickel sulphate in place of 0.200 grm., at the end of twenty-four hours the precipitate is already very notable, and it continues to increase very rapidly. After four days' exposure to temperatures between 12° and 16° 0.305 of the sulphate, or more than 27 per cent of the quantity employed, has been converted into sulphide.

If the same metallic solution is mixed with 3 grms. of acetic acid the formation of the sulphide is a little less rapid, but it still begins in a comparatively short time. It is only on adding a much larger quantity of acetic acid

that the formation of the sulphide is retarded or arrested.

To annul the action of hydrogen sulphide upon nickel sulphate in solution there must be added quantities of acetic acid so much the greater as the proportion of metallic salt is higher. It has been previously shown that the nickel sulphate is decomposed in the cold by hydrogen sulphide, whence it appears that this rule is in harmony with that of the author's first note, in which he has established that in order to understand why an acetic solution of nickel acetate is not at once precipitated by the action of sulphuretted hydrogen, regard must be had to the proportions of acetic acid and nickel oxide present. From this action of acetic acid the author has deduced a method for the preparation (? separation) of nickel and zinc in the state of sulphates.

Though in the cold acetic acid retards or hinders the action of sulphuretted hydrogen upon nickel sulphate in solution, at a high temperature in a closed vessel, e.g., at 100° , its action is nil.

It is found that a solution of 0.200 grm. of the nickel salt in 140 c.c. of water and mixed with 3 grms. acetic acid begins to take a slight black tint if it is kept for three hours at 40° , whilst at 20° it only gives an appreciable quantity of sulphide after the lapse of several days. At 100° the precipitation is almost complete after three hours, the liquid retaining then less than 0.001 grm. of sulphate. It is even observed that with a solution containing 1.1 grm. sulphate in 140 c.c. of water acidified with a proportionally increased quantity of acetic acid, after the lapse of three or four hours at 100° , the weight of sulphate still in solution does not exceed 0.006 to 0.007 grm. These are substantially the same results as those obtained with an aqueous solution of neutral sulphate heated to 100° .

Experiment proves that the proportion of acetic acid may even be increased beyond the quantity necessary to annul the action of the hydrogen sulphide in the cold without having any effect in heat. Thus 0.200 grm. nickel sulphate dissolved in 140 c.c. of a liquid saturated at 0° with sulphuretted hydrogen and containing about 25 per cent of acetic acid are precipitated as sulphide after four hours' action at 100° the liquid only retaining a weight of sulphate less than 0.0005 grm.

It may therefore be said that for nickel sulphate in an aqueous solution acidulated with acetic acid everything takes place in heat, in presence of hydrogen sulphide and in a closed vessel, as if the solution contained merely the neutral sulphate.

The author will show that from this observation may be derived a method of separating nickel and iron in the state of sulphates. The details will be given on a future occasion.—*Comptes Rendus*.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING JUNE 30TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

July 3rd, 1882.

SIR,—We submit herewith the results of our analyses of the 188 samples of water collected by us during the month of June, on the days and at the times indicated, from the mains of the seven London water companies asking their supply from the Thames and the Lea.

Of these 188 samples, 25 were from the mains of the New River Company, 26 were from the mains of the East London Company, 24 were from the mains of the Chelsea Water Company, 26 were from the mains of the West Middlesex Company, 26 were from the mains of the Lambeth Water Company, 26 were from the mains of the Grand Junction Company, and 26 were from the mains of the Southwark and Vauxhall Company. The whole were found to be well filtered, clear, and bright.

In Table I. we have recorded the analyses in detail of samples, one taken daily from June 2nd to June 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be seen that during the past month the condition of the waters, not only in respect to entire freedom from turbidity, but also in respect to colour, state of aëration, and freedom from excess of organic matter, was unexceptionable. The average proportion of organic carbon found in the 25 samples of water examined for this constituent amounted to 0.108 part in 100,000 parts of water, corresponding to less than one-fifth of a grain of organic matter per gallon.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOOT TIDY.

ON THE DETERMINATION OF REVERTED PHOSPHATES.*

By THOMAS S. GLADDING, A.M.

IN an investigation on the subject of reverted phosphoric acid the first question that arises is, What is meant by this term? The curious phenomenon of a decrease in the amount of soluble phosphate in a superphosphate, and its reversion into a form insoluble in water, but soluble in the organic salts of ammonia, in weak acids, and other reagents, has been attributed to several different causes.

According to the most common explanation† it is due to the gradual interaction between the soluble or monocalcic phosphate formed in the manufacture, and the still undecomposed tricalcic phosphate of the original rock, this reaction resulting in the formation of the intermediate compound dicalcic phosphate.

Again, it has been noticed that this reversion is especially large when the amounts of iron and alumina present are considerable, and in such cases it has been attributed‡ to the formation of phosphates of iron and alumina having the solvent properties specified above.

Again, from experiments in our own laboratory it has been found that this reversion is very noticeable in acid phosphates which, after treatment with sulphuric acid, have been mixed with natural phosphates containing large amounts of carbonate of lime. The reaction that takes place between the monocalcic phosphate and carbonate of lime probably results in the formation of either the dicalcic or tricalcic phosphate. This latter salt, though insoluble in water, is readily taken up, on account of its fine state of division, by the reagents used for the estimation of reverted phosphates.

From these different explanations of the character of reverted phosphate it is evident that the term is not capable of a strict chemical definition. It may consist, in any given case, of one or of several chemical compounds. The best definition that can be given is the general one condensed into the name itself. Reverted phosphates are those which, originally insoluble, but having been made soluble, have reverted or returned to the insoluble condition. They must now, however, be looked upon as—

(1.) Just over the border line that separates the soluble from the insoluble, lying very close to the soluble, and being brought back by a slight addition to the solvent power of water; and as—

(2.) Widely separated and different in solubility from the insoluble form which they originally possessed. Like the flats lying just above the river's edge, they must be wholly covered by a slight rise in the water that affects the banks but little.

The object of the inquiry here described has been to establish the above distinctions, and to find a method of separation that shall in the actual analysis recognise them as nearly as possible. The course pursued has been that followed in similar inquiries:—

- I. An examination of the solubility of the different natural phosphates used in the manufacture of superphosphates.
 - II. An examination of the solubility of the different chemical compounds of which reverted phosphates have been found to consist; and—
 - III. An attempt based upon the results of these two inquiries to find the best method of separating these two classes.
- In the examination of the natural phosphates five different forms were taken as typical of all. These were—
1. *Apatite*, as type of the nearly pure tricalcic form in its most insoluble condition.
 2. *South Carolina Rock*, containing, besides tricalcic phosphate, phosphates of iron and alumina, and carbonate of lime.
 3. *Bone Ash*, the great organic source of phosphate.
 4. *Navassa Rock*, typical on account of its large percentage of iron and alumina; and finally—
 5. *Curaçao Phosphate*, as type of the island phosphates, notable for their peculiar mechanical condition and greater solubility in the organic salts of ammonia.

In examining the solubility of these natural phosphates attention was first given to the effect of different relative proportions of phosphate and solvent. The standard method of Fresenius, Luck, and Neubauer* was followed, using 50 c.c. of citrate of ammonia solution, of sp. gr. 1.09, and made as nearly neutral as possible; time, thirty minutes; temp., 35° C. Two series of experiments were made. In the first, 1 gm. of substance was taken; in the second, 1-10th of a gm.

	SERIES I. P ₂ O ₅ dissolved.	SERIES II. P ₂ O ₅ dissolved.
Apatite	0.40 per cent.	1.54 per cent.
S. Carolina rock ..	2.00 "	6.60 "
Bone ash	2.60 "	8.30 "
Navassa	2.65 "	10.10 "
Curaçao	4.40 "	16.00 "

Comparing these tables, we see at once the fact that has been commented upon very frequently of late by German chemists as regards superphosphates, and to which special attention has been called within a few months by a printed letter of Dr. S. W. Johnson, in the case of Curaçao phosphate, namely, that the percentage of phosphate dissolved increases very largely with the increase of solvent, or, what is the same, the decrease of substance taken for analysis. These tables show that this is true not only of reverted phosphates as found by the former, nor of Curaçao phosphate as shown by the latter, but also of all natural phosphates, including even

* *American Chemical Journal*, vol. iv., No. 2. Read before the American Chemical Society, March 17, 1882.

† *Zeit. für Analyt. Chem.*, x., Fresenius.

‡ *Zeit. für Analyt. Chem.*, xix., Z. Meyer.

* *Zeit. für Analyt. Chem.*, x.

the difficultly soluble apatite. This fact has a very important bearing upon the error involved in the determination of reverted phosphoric acid by this method, i. e., an error as regards the strict separation of the reverted phosphates from the insoluble phosphates. Thus, supposing five superphosphates after the extraction of the soluble to contain no reverted phosphate, but to contain 10 per cent of the above raw phosphates respectively, corresponding to about 3 per cent of insoluble phosphoric acid, the citrate would attack these raw phosphates, and instead of the error being 0.04, 0.20, 0.26, 0.26, and 0.44 per cent, as would naturally be supposed from Series I., it would in reality be 0.15, 0.66, 0.83, 1.01, and 1.60 per cent, as shown by Series II. Thus the superphosphates would be reported as containing these latter amounts of reverted phosphoric acid, when in fact they contained none whatever.

This same fact of increased solvent power obtained by increasing the amount of solvent salt was shown to be true also of oxalate of ammonia, by treating 2 grms. of Navassa rock and Curaçao phosphate with 1, 5, and 10 grms. of the salt dissolved in 100 c.c. of water, at a temperature of 100° C. for thirty minutes.

SERIES III.

	1 grm.	5 grms.	10 grms.
Navassa, P ₂ O ₅ dis...	2.20	8.75	12.15
Curaçao, " " "	2.50	12.30	17.60

The influence of increase of temperature upon the amount of rock dissolved was shown by treating 1 grm. of the different phosphates with 100 c.c. of water containing 4 grms. of oxalate at 20° C. and at 100° C.

SERIES IV.

	Apatite.	S. Car. Rock.	Bone Ash.	Navassa.	Curaçao.
At 20° C., P ₂ O ₅ dis.—					
	0.36 p.c.	2.25 p.c.	2.72 p.c.	2.85 p.c.	5.51 p.c.
At 100° C., P ₂ O ₅ dis.—					
	2.16 p.c.	5.80 p.c.	8.78 p.c.	9.40 p.c.	15.30 p.c.

In performing the above experiments at 100° C. a strong odour of evolved ammonia was observed, and it was also found that the filtrates were decidedly acid in reaction. The importance of this and its bearing upon the subject will be better seen further on.

The results thus far given show very clearly the cause of much of the confusion that has arisen over the determination of reverted phosphates. This lies in the great facility with which the citrate and oxalate solutions attack the insoluble phosphate, especially when the proportion of solvent is increased or when the temperature of digestion is raised. Many chemists have been led by these difficulties to seek a better method. The suggestion has frequently been made that a weak or dilute acid be employed as a substitute for the organic salts of ammonia. Thus Grupe and Tollens* recommend the use of a ½ per cent citric acid solution. The solvent power of this acid of ½ per cent, also of oxalic acid of ½ per cent and ¼ per cent, also of hydrochloric acid of ⅙ normal strength, upon the natural phosphates, was examined. 100 c.c. of each of the above solvents were taken; the temperature of digestion was 40° C., time one hour. One grm. was taken with each acid, and in addition also ⅙th of a grm. with the citric acid of ½ per cent.

SERIES V.

Supposing a fertiliser to contain 10 per cent of insoluble rock, the citric acid would make the reverted phosphoric acid 0.27 per cent, 1.14 per cent, 1.18 per cent, 1.40 per cent, 1.98 per cent respectively in excess of the actual amount present. The excess thus introduced would be considerably greater than that caused by the solvent action of the citrate of ammonia solution (*vide* Series II.) and

Acid employed:—

	Citric, ½ per cent.		Oxalic, ½ per cent.	Oxalic, 1-10 per ct.	HCl, 1-100 normal.
	1 grm.	1-10 grm.	1 grm.	1 grm.	1 grm.
Apatite, P ₂ O ₅ dis.—					
	0.74 p.c.	2.70 p.c.	3.20 p.c.	1.08 p.c.	2.56 p.c.
S. Car. rock, P ₂ O ₅ dis.—					
	2.80 p.c.	11.40 p.c.	8.75 p.c.	2.68 p.c.	4.25 p.c.
Bone ash, P ₂ O ₅ dis.—					
	3.80 p.c.	11.80 p.c.	9.23 p.c.	4.15 p.c.	3.85 p.c.
Navassa, P ₂ O ₅ dis.—					
	3.30 p.c.	14.00 p.c.	9.96 p.c.	3.50 p.c.	4.15 p.c.
Curaçao, P ₂ O ₅ dis.—					
	4.20 p.c.	19.80 p.c.	9.12 p.c.	4.00 p.c.	3.35 p.c.

the claim made for the citric acid solution by Grupe and Tollens, that it dissolves nearly the same amount of phosphate from different quantities of substance taken for analysis, shown to be wholly unfounded as regards its action on raw phosphates. (Compare columns 1 and 2 above).

The action of the different solvents upon the dicalcic and tricalcic salts was next studied. These salts were obtained by precipitation, and on analysis found to agree so closely with the theoretical composition as to show the admixture of traces only of other forms. After thorough washing they were mixed with about an equal weight of calcium sulphate, in order to imitate the conditions under which they are found in a superphosphate. These mixtures were then thoroughly air-dried. One grm. of each was now treated with the different solvents, already employed, for thirty minutes at a temperature of 40° C. The mixture of the dicalcic salt contained 19.20 per cent of P₂O₅, of the tricalcic salt 13.00 per cent.

SERIES VI.

Solvent.	2CaOP ₂ O ₆ .	3CaOP ₂ O ₆ .
100 c.c. ½ per cent citric acid, =	10.60 p.c.	10.26 p.c.
P ₂ O ₅ dis.	9.31 "	
100 c.c. ⅙ per ct. oxalic acid,	5.32 "	5.10 "
P ₂ O ₅ dis.		
100 c.c. ⅙ normal HCl acid,	3.42 "	1.90 "
P ₂ O ₅ dis.		
50 c.c. cit. of ammonia sol.,	19.20 "	13.00 "
P ₂ O ₅ dis.		
50 c.c. H ₂ O + 1 grm. oxal.	19.00 "	11.50 "
ammon., P ₂ O ₅ dis. . . .	19.05 "	

It will be seen from this table that the citrate solution dissolves both forms perfectly; that the citric acid, though fairly successful with the tricalcic salt, dissolves only one-half of the dicalcic salt; that the other acids, notably the mineral acid HCl, fall far below the citric in this respect. Special attention is called to the vigour of the weak solution of oxalate of ammonia. Though only 1 grm. is used it dissolves all but a trace of the dicalcic salt, and falls but little short of dissolving all the tricalcic form. In the original article of Fresenius, Luck, and Neubauer, the weak acids were discarded on account of their inability to take up the reverted phosphate. This conclusion is corroborated by these experiments, with the additional objection proved by Series V., namely, the greater extent to which they dissolve the insoluble phosphate. They found also that oxalate of ammonia solution dissolved the dicalcic phosphate equally with the citrate salt, but abandoned its use on account of the vigour with which it attacked the raw phosphates. But they employed in their published experiments a very large amount of oxalate, 6 grms. of the salt being taken. But it is here found that a much weaker solution of the oxalate is effective for dissolving the dicalcic salt. As to its solvent action upon the natural phosphates, a series of experiments proved that it was not as energetic in this respect as the citrate of ammonia so-

* *Berichte der Deutsch. Chem. Gesellschaft*, xiv., 754.

lution, dissolving considerably less than the latter. On account of the many advantages possessed by an oxalate of ammonia solution over the citrate solution—(1) as regards ease of preparing a perfectly uniform neutral solution, (2) as to the greater facility of filtering and washing, and many others—many chemists urged and secured its adoption at the Cincinnati convention of agricultural chemists of 1881. But further experiments, to be described later, reluctantly compelled the conclusion that it cannot supersede the citrate of ammonia solution.

A series of experiments were now made upon a sample of acid phosphate, in order to compare the results obtained by the different methods, and to throw light, if possible, upon the causes of discrepancy. A sample made from Navassa rock was chosen on account of the large amount of reverted phosphate usually present in this class of fertilisers. The total phosphoric acid in the sample was 17.00 per cent, the soluble was 5.00 per cent, leaving 12.00 per cent. of reverted and insoluble. After thoroughly washing out the soluble, one grm. was treated with 50 c.c. of citrate of ammonia solution, and the directions of Fresenius carefully followed. Another grm. was treated in exactly the same way, using, however, as a solvent 50 c.c. of water containing in solution one grm. of oxalate of ammonia. The following results were obtained:—

SERIES VII.

	P_2O_5 dissolved. P_2O_5 undissolved.	
By citrate solution or "Washington Method"	6.10 per cent.	5.90 per cent.
By oxalate solution ..	6.15 "	5.85 "

These two methods give results that are gratifying as regards their agreement. Subsequent experiments, however, showed conclusively that both were far from the truth.

Two grms. of the same sample were now, after the extraction of the soluble phosphate, treated according to the method adopted by the agricultural chemists at Cincinnati, known as the "Cincinnati method." "The two grms. of residue were washed from the filter-paper into a beaker with 100 c.c. of water, containing in solution two grms. of oxalate of ammonia. (This is the same amount of oxalate in proportion to the quantity of substance taken as is used in the above determination). 400 c.c. of water are brought to boiling, and the beaker closely covered now introduced in the boiling water, the lamp being at the same time removed. The temperature of the liquid in the beaker will rise to about 70° C. in a few minutes, and will then slowly sink during an hour to about 40° C. The beaker is briskly rotated at intervals." Two grms. were treated in exactly the same manner, using, however, instead of the oxalate solution 100 c.c. of the citrate solution.

SERIES VIII.

	P_2O_5 dissolved. P_2O_5 undissolved.	
By oxalate of ammonia	8.55 per cent.	3.45 per cent.
" citrate "	9.85 "	2.15 "

The point of interest connected with these results is the much larger amount of phosphoric acid dissolved by both the reagents as compared with that dissolved by them at the temperature of 35° C. continuous. This is especially the case with the citrate solution, the dissolved phosphoric acid rising from 6.10 per cent to 9.85 per cent, an increase of 3.75 per cent. This increase can be explained in two ways only: (1) Either the insoluble rock present is dissolved to this increased extent, or (2) there is a form of reverted phosphate present that is not fully taken up by either the citrate or oxalate solution at the lower temperature.

In order to ascertain if the former of these two explanations was the correct one, two separate portions of $\frac{1}{2}$ of a grm. each of Navassa rock containing 0.120 grm. P_2O_5 , and corresponding to 6 per cent of insoluble phosphoric

acid when calculated on 2 grms. as fused in the above analysis (which is just the amount of apparently insoluble acid left in Series VII.), were rubbed to a paste in a mortar and treated each with 100 c.c. of citrate of ammonia solution, the one at a temperature of 35° C. continuous for one hour, the other at a temperature falling from 70° C. to 40° C. during an hour, as in Series VIII. The following amounts of P_2O_5 were dissolved, calculated as per cent on 2 grms.:—

SERIES IX.

No. 1. Phos. acid dissolved, ..	1.16 per cent.
No. 2. " " "	1.59 "

The increase in phosphoric acid dissolved by the use of the higher temperature is found to be only 0.43 per cent. It is seen at once that this small increase cannot explain the large increase of 3.75 per cent in the case of the acid Navassa, made from the same rock.

The second of the two possible explanations, viz., the presence of a form of reverted phosphate not fully dissolved at 35° C., must therefore be the true one. The experiments already made show that this form can be neither the dicalcic nor tricalcic phosphates, as the citrate solution is a perfect solvent for these two forms at a temperature of 35° C. The only form left is the reverted phosphate of iron and alumina. A quantity of the mixed normal phosphates of iron and alumina, Fe_2O_3 , P_2O_5 , and Al_2O_3 , P_2O_5 , was now prepared by precipitation. A portion was mixed with a large quantity of calcium sulphate and dried to a powder at a temperature not exceeding 60° C. The remainder was dried at the same temperature without admixture. One grm. of the first portion containing 4 per cent of phosphoric acid was now rubbed to a paste in a mortar and then digested with 100 c.c. of the oxalate and citrate solutions, first at 35° C. and then at 70° C. to 40° C. for one hour.

SERIES X.

	P_2O_5 dis. at 35° C. P_2O_5 dis. at 70° to 40° C.	
Using oxalate of ammonia,	0.95 per cent.	3.20 per cent.
" citrate "	1.60 "	4.00 "

One grm. of the unmixed portion containing on analysis 35.62 per cent of phosphoric acid was now treated in exactly the same way, with results as follows:—

SERIES XI.

	P_2O_5 dis. at 35° C. P_2O_5 dis. at 70° to 40° C.	
Using oxalate of ammonia,	11.06 per cent.	26.50 per cent.
" citrate "	13.14 "	35.62 "

These two series of experiments prove the very important fact that neither the citrate nor oxalate solution will dissolve more than a small portion of the reverted phosphates of iron and alumina at the temperature of 35° C., and that even at the higher temperature of 70° C. to 40° C. the oxalate falls short of the perfect solvent power which must be required of it.

These results explain most clearly the great increase of phosphoric acid taken up in Series VIII. over that dissolved in Series VII. The acid Navassa under treatment contains a very large quantity of reverted phosphates of iron and alumina which are not dissolved at the lower temperature. They also explain why the citrate solution dissolves 1.30 per cent more than the oxalate, because of its more vigorous solvent action on these forms of reverted phosphates. One grm. of these phosphates of iron and alumina, treated with 100 c.c. of the citrate solution at a continuous temperature of 65° C. for 30 minutes, formed also a clear solution.

In order to ascertain the amount of solvent action of this method upon the different forms of raw phosphates, $\frac{1}{4}$ of a grm. of each, corresponding to about 3 to 4 per cent phosphoric acid when calculated upon 2 grms., was treated in the same manner as the above, temperature 70° C. to 40° C., using 100 c.c. citrate solution.

SERIES XII.

		P ₂ O ₅ dissolved.
Apatite	0.22	per cent.
South Carolina rock ..	0.61	"
Bone Ash	—	"
Navassa rock	1.09	"
Curacao	2.07	"

Comparing this table with Series II., dividing the results there by ten, it is evident that at the higher temperature only a small increase in the amount of insoluble rock dissolved is observed.

In this connection special attention is called to one point. Notice has been called to the fact that at 100° C. the oxalate solution loses ammonia and becomes decidedly acid in reaction. A solution of neutral oxalate, immersed in boiling water for one hour in an open beaker, acquired an acid strength of $\frac{1}{2}$ per cent oxalic acid; 100 c.c. of the citrate of ammonia solution treated for an hour in the same way acquired an acid strength of 1.2 per cent citric acid. The energy with which these acid solutions attack the undecomposed rock present in a superphosphate is shown in Series V. It is on account of these facts that Fresenius uses a neutral solution of the citrate salt and adopts the low temperature of 35° C., and Luck* in a second paper dwells with great emphasis upon this point in answer to the criticisms of a French chemist. But as the higher temperature is rendered indispensable on account of the presence of phosphates of iron and alumina in the great majority of superphosphates, this loss of ammonia and consequent acidity was prevented by digestion in a flask closed with a rubber cork.

The severest criticism upon the determination of reverted phosphates as an analytical process is the fact that when different quantities of substance are taken for analysis, different results are obtained. This most exceptional experience in chemical analysis, which is without a parallel in analytical determinations, requires a most careful examination, as this has done more than all else to cast discredit upon this analytical process. And yet it seems clear that this trouble can arise from only three sources:

- (1) Either the fertiliser under treatment has so large an amount of reverted phosphate present that when a large amount is taken for analysis the citrate is unable to take it all up, but is able to do so when a smaller amount is employed, or—
- (2) The citrate is an imperfect solvent for some form of reverted phosphate that may be present, either on account of the character of the latter, or on account of the method employed failing to dissolve it completely, the error showing more clearly as larger quantities are taken for the analysis, or—
- (3) The discrepancy arises from the solvent action of citrate upon the undecomposed rock present, a large percentage of this being dissolved when smaller quantities are taken (*vide* Series I. and II.). The instances given by German experimenters, in the case of fertilisers containing 25 per cent or more of phosphoric acid present as precipitated tricalcic phosphate, may be due mainly to the first of these causes. In such cases a smaller quantity must be taken, or it may be found that the higher temperature here recommended will so increase the solvent power of the citrate solution as to render this unnecessary. Whenever the phosphates of iron or alumina are present, it is evident from the experiments given that this discrepancy may be largely due to the second cause here assigned, namely, the method of the analysis, employing as it does the low temperature of 35° C. In order to ascertain whether the higher temperature of 70° C. to 40° C. will obviate the error from this second cause, 1, 2, 3, 4, and 5 grms. of the above acid Navassa were treated each with 100 c.c. of the citrate solution at this temperature, after the thorough washing out of the soluble phosphate.

(To be continued.)

NOTICES OF BOOKS.

The Retrospect of Medicine, being a Half-yearly Journal containing a Retrospective View of every Discovery and Practical Improvement in the Medical Sciences. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M.D. Vol. lxxxv., January to June, 1882. London: Simpkin, Marshall, and Co.

THIS volume contains the usual summary review of medical and surgical progress for the past half-year. Among the most widely-interesting portions of the contents we may mention five papers on that most complicated and difficult subject, the nature of zymotic poison. Dr. Dougall, in one of these, expresses himself as opposed to the germ theory in its ordinary form. He declares himself convinced that no living thing, germ or other, vegetable or animal, could resist the temperatures employed by Dr. Bastian in his experiments on abiogenesis. With Prof. Owen, he holds that the functions of bacteria, &c., are not malignant, but beneficent. He maintains that Pasteur, Koch, Lister, &c., "tacitly admit the physico-chemical theory, whilst ostensibly discarding it," and that "probably all, at least certainly most, of their results may be as easily explained on the physico-chemical as on the germ theory." The editor of the *Lancet*, commenting on the experiments of Rosenberger, where septicæmia was produced by the injection of virus so treated as to destroy all the bacteria present, suggests that some of them must have escaped the "cooking" process, and have survived in a condition to develop in the favourable soil of a living organism, although not in a mere culture-liquid. Dr. Harley, in a memoir on the action of germs in the production of human diseases, mentions some exceedingly interesting facts connected with the rapidity of decomposition. One case was that of a girl who had died after a few hours of illness at a "Blood manufactory" for sugar refining purposes. The body was green and putrescent within thirty-six hours of death. It is suspected that the blood of diseased horses from the knacker's yard was being employed.

No candid person will be able to read these papers without being driven to two conclusions,—the prodigious difficulty of some of the questions with which medical science has to grapple, and secondly the utter hopelessness of their solution without experimentation upon animals.

We note an instance of a man suffering from irritation in the feet plainly caused by his boots, who ascribed the affection to the dye of his stockings. They coloured water green, *ergo* they were dyed with some poisonous substance!

Of two persons suffering from diphtheritic ophthalmia, one, a porter at Smithfield meat market, thought he had acquired the disease by contact with an acrid "sweat" on some diseased American pork. The other, a slaughterman, volunteered the statement that he had often killed diseased animals, and that few calves, "not one in ten," have perfectly healthy livers.

Prof. Semmola, of Naples, makes a novel and successful application of electrolysis in the treatment of malignant tumours.

Catechism of Modern Elementary Chemistry. By E. W. v. VOLCKXSON, F.C.S., Lecturer on Chemistry at Downside College, Bath. London: Kegan Paul and Co.

"THE value of this work," says the author, "for candidates at matriculation of the London University cannot be overrated, as it contains the answers to all the questions which have been set at that examination for about forty years." These questions have been arranged according to the subject-matter, and under each is given the dates of the examination when it was set. It is added, somewhat naively,—"These dates will thus show how frequently any question has been repeated, and will therefore

indicate to students and teachers the points upon which special stress should be laid." The primary object of the work, therefore, is to enable candidates to "pass," and to give to teachers a wrinkle in the art of "grinding" or "coaching." We recollect that a work which gave in a somewhat similar manner a list of the questions set and answers given during former years at certain examinations was somewhat severely handled by some of our contemporaries, as pointing out a way of passing through the fashionable ordeal with a minimum of labour and of knowledge. We do not endorse this censure. So long as the present utterly mistaken value is set upon "passing," we hold that teachers are perfectly justified in finding out all the weak spots through which it is possible to drive, as through an Act of Parliament, the traditional "coach and six." The more such guides are published and acted on the sooner will examinationism, like the shares of a bubble company, fall to its true value.

For the questions asked and the answers given Mr. von Volckxson is of course in no way responsible. To one question and to its reply we must draw passing attention. It is asked: "In what points is gun-cotton analogous to gunpowder?" Had we been the unfortunate examinee we should have replied, 'Simply in being explosive, though the bodies are chemically heterologous, the one being a compound and the other a mechanical mixture.'" On turning over the page we find the accepted answer is:—"Gun-cotton is analogous to gunpowder chiefly because it contains in itself in every part of the mass the oxygen necessary for complete combustion." Now if we refer to the last edition of "Miller's Chemistry," edited by Dr. H. E. Armstrong and C. E. Groves (vol. iii., p. 649), we find the formula of tri-nitro-cellulose given as $C_6H_7(NO_3)_3O_2$. Hence it appears that even if all the nitrogen were evolved in the free state there is not oxygen enough for complete combustion, that is, for converting all the carbon into carbon dioxide, and all the hydrogen into water. But all the nitrogen is not deoxidised. At the great Stowmarket explosion in 1871 the column of smoke and vapour which was shot up into the atmosphere was plainly seen to be bordered with orange-coloured fumes. It is in virtue of this deficiency of oxygen that some inventors have endeavoured to improve gun-cotton by adding to it some substance rich in oxygen, e.g., a nitrate.

CORRESPONDENCE.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

SIR,—In Mr. Casamajor's* exposition of the strange mistake made by Tucker in his "Sugar Analysis," in regard to the estimation of sucrose by Clerget's method, he remarks that it would have been better to have determined the effect of heating with mineral acids upon the rotatory power of commercial grape-sugar. I beg leave to call attention to the fact that this has already been done, by the same person to whom Tucker evidently refers when he speaks of "analyses of sugars containing large amounts of commercial grape-sugar having been published, &c." Prof. Wiley (*Jour. Am. Chem. Soc.*, vol. ii.) has shown that quite a considerable error is introduced by the heating of commercial starch-sugar with acid. I would also remark that I have thoroughly examined Landolt's article, to which Tucker refers, in support of his position,† and find nothing to warrant him in his statement that Landolt says that Clerget's method is inapplicable where other optically active bodies besides cane and invert sugars are present. What Landolt does say is that the direct polarisation gives correct results only when the solution

contains no optically active substances except cane-sugar, and in these cases the results are controlled by Clerget's method. I wish to point out another error in Tucker's work. On page 285 he says—"On account of the high rotatory power of starch-sugar, a refined sugar mixed with it will show a larger percentage of cane-sugar by the saccharimeter than the true one; hence the analysis generally adds up over one hundred."

This is not the case. Mixed cane- and starch-sugars do not polarise higher than pure cane-sugars, but rather lower, if there is any difference. The highly converted starch-sugar used for mixing contains a very large percentage of dextrose, which has (after heating) a specific rotatory power of about 53 for the sodium ray, while the specific rotatory power of sucrose for the same ray is about 66. In the glucose syrups, where the percentage of the highly rotatory sugars, maltose, and dextrin is greater, the rotation is much higher. In an examination I have made of 25 samples of mixed sugars, the highest direct rotation in any sample was 93.7, the lowest 78.5, on the cane-sugar scale. This is not far from the range of the cane-sugars of commerce, certainly not higher. The highest rotation I ever found in a solid starch-sugar was 96.4 on the cane-sugar scale of a Laurent instrument, requiring 16.2 grms. pure sugar to read 100 on the scale. The glucose syrups will frequently go over 100.

I have no doubt but that the manufacturers regulate their mixtures so as to have the polarisation approximate as closely as possible to some grade of straight sugar. Such a sugar would pass inspection with such sugar chemists as Tucker, who never make an inversion, but take without question the direct reading of the polariscope for the percentage of cane-sugar—unless it should go over 100!—I am, &c.,

CHAS. A. CRAMPTON.

Ann Arbor, Mich., U.S.A.,
June 24, 1882.

FLAMELESS COMBUSTION.

To the Editor of the Chemical News.

SIR,—That combustion of hydrocarbons is to a limited extent possible without flame is well known, but that it is possible on a large scale with good results is, I think, new. The first time this fact was publicly demonstrated was at the Soirée of the Society of Chemical Industry at Owens College on the 6th inst., when, directing a gas flame on a large mass of iron wire until red-hot, I gradually turned a blast of air on until the flame totally disappeared. As the flame became smaller the temperature increased until, on its disappearance, the iron fused and ran into drops, the whole mass being intensely heated, and remaining so notwithstanding the fact that not a trace of flame could be detected in a perfectly dark room. It was evident that the highest temperature was obtained when the flame was totally absent.

As a further demonstration, proving that the combustion of the iron is not a necessary condition, the highest temperatures in the injector furnace are obtained only when the gas is burnt in the furnace without flame. It would appear that not only is flame unnecessary, but its presence may be considered a proof of imperfect combustion.

It is a matter of considerable interest whether this admits of practical application; whether the absence of flame is a universal law when the combustion of any substance takes place under the most perfect conditions.—I am, &c.,

THOS. FLETCHER.

Museum Street, Warrington.

Valuation of German Yeast.—E. Geissler.—The author adds a known quantity to 100 grms. of a 10 per cent solution of sugar at 25° to 30°, and determines the carbonic acid evolved in an hour.—*Zeit. f. Anal. Chem.*

* CHEMICAL NEWS, vol. xiv., p. 150.

† In his letter to the CHEMICAL NEWS, vol. xlv., p. 86; *Jour. Prakt. Chem.*, ciii., p. 4.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 25, June 19, 1882.

Reaction Current of the Electric Arc.—M. Jamin and G. Maneuvrier.—The two alternating currents in opposite directions given by Gramme's self-exciting machine are absolutely equal; consequently they do not decompose water, and a tangent compass introduced into the circuit experiences no deviation, since the contrary effects which follow at very short intervals destroy each other. This destruction of the effects is maintained if we introduce into the circuit one or more burners, provided that the two carbons are equal, identically arranged, and are equally heated. If we introduce eight to ten Bunsen elements into the circuit they give the compass, when the machine is at rest, a deviation δ , and if it is in action a deviation δ' , absolutely equal to δ . This equality proves that the resistance of the wires of the machine for a current derived from an exterior source does not change, whether the machine is at rest or in action. It proves, further, that the two effects of the machine and the battery are superposed and independent of each other. If we now suppress the battery and introduce into the circuit a burner formed of two unequal carbons, the one thick and the other slender, this want of symmetry suffices to determine a permanent deviation of the compass as if a battery had been introduced. The two systems of inverse currents given by the machine cease to be equal; that which sets from the thick carbon to the thin one prevails over that in the opposite direction. Hence there results a differential current, which is shown by the compass and which is so much the more intense as the difference of thickness of the two carbons is greater.

The Reciprocal Displacements of the Halogens, and the Secondary Compounds by which it is Influenced.—M. Berthelot.—In the reciprocal displacements of the halogens as well as in the conditions almost numberless which the author has examined since the outset of his researches, the direct and inverse reactions and the equilibria remain invariably submitted to thermochemical laws.

Separation of Gallium.—Lecoq de Boisbaudran.—See p. 3.

Determination of Atmospheric Carbonic Anhydride to be Effected at Cape Horn.—A. Müntz and E. Aubin.—The authors merely describe the apparatus they have arranged for the expedition to Cape Horn.

Products of the Distillation of Resin.—A. Renard.—The yield of butyric and valerianic acids is 2 to 3 per cent of the crude essential oil obtained. The butyric acid is the isobutyric acid of Kolbe, boiling at 152° to 155° . The valerianic acid boils at 173° to 175° ; its density at $+16^{\circ}$ = 0.941. It presents great analogies with ordinary valerianic acid, but is clearly distinguished by its zinc salt.

Microzymas as the Cause of the Decomposition of Oxygenated Water by the Tissues of Animals and Plants.—M. Béchamp.—Reverting to the observation of Thénard that among the immediate principles of organic origin, the fibrine of the blood alone separates oxygen from hydrogen peroxide, the author undertakes to show that the power of the tissues to effect the same decomposition is due to the fact that the blood conveys its microzymas into all parts of the organism.

Various Properties of Hydrocyanic Acid.—C. Brame.—Hydrocyanic acid in vapour determines a scarcely

visible turbidity in the white of egg or in a solution of albumen. Hydrocyanic acid dissolved in water precipitates abundantly pure albumen and its aqueous solution. The preservation of the bodies of animals poisoned with hydrocyanic acid is prolonged for a year. The rabbits, &c., poisoned with this acid, which figured at the Industrial and Artistic Exhibition of Tours, are still in good preservation, though they several times during the Exhibition underwent a temperature of 38° . After some months the bodies of animals injected or poisoned with hydrocyanic acid and preserved in stoppered vessels, lose all the odour of this acid, and take that of ammonium formiate, a salt which may be detected in the serous liquid. Ammonium formiate prepared directly with ammonia and formic acid gives a crystalline deliquescent matter, so that to obtain it the liquid must be evaporated over sulphuric acid with exclusion of air. In embalming with hydrocyanic acid it will be necessary to introduce into the body a small quantity of some matter which will harden on absorbing moisture (zinc chloride).

Chemical Composition of the Different Layers of a Current of Lava from Etna.—L. Ricciardi.—The author has analysed six specimens of the lava of 1669 taken at different depths of one and the same stream and in the same perpendicular plane. The only difference between the layers is in the different proportions of iron in the highest stage of oxidation.

Comparison of the Alkaline Chlorides as to their Poisonous Power and the Minimum Fatal Dose.—C. Richet.—The author has experimented with the chlorides of lithium, sodium, potassium, rubidium, and caesium, injected subcutaneously. According to him there is in the series of the alkaline metals no relation between atomic weight and physiological activity. Rubidium, which has a high atomic weight, is much more inoffensive than sodium. Lithium, which has the lowest atomic weight of the metals, is fatal in very small doses.

Zeitschrift für Analytische Chemie.
Vol. xxi., Part 1, 1882.

Determination of Traces of Organic Matter in Potable Water.—W. L. Hiepe.—The author adds to 500 c.c. of an apparently good water 1 c.c. of a 1 per cent solution of oxalic acid and evaporates down in a glass capsule with the precautions laid down by Prof. Frankland. The residue is covered with a thin layer of calcium carbonate, scraped loose from the glass by means of a flexible steel spatula; the capsule rinsed out two or three times with calcium carbonate, and the whole introduced into a combustion-tube, which is filled up with soda lime in the usual manner, and with an asbestos plug. The end of the tube is then drawn out at the blast-lamp, so that it may plunge into a 1-per cent solution of oxalic acid. The combustion is conducted slowly till the evolution of gas ceases. The drawn-out end of the tube is broken off, rinsed in the oxalic acid, the latter distilled with alkali, and the ammonia is determined colorimetrically in the distillate.

The Schulze-Tiemann Apparatus for Determining Nitric Acid in Potable Waters.—C. H. Wolf.—A modification of that figured in the sixth edition of Fresenius's "Treatise on Quantitative Analysis."

Examination of Beer.—H. Dragendorff.—An extensive memoir, describing a method for detecting the presence of bitter principles other than that of the hop.

Determination of Phosphorus in Iron and Steel.—A. E. Haswell.—The borings are covered with a 7-per cent solution of ammonio-cupric chloride in a well-corked flask, which is kept cool by being set in cold water. After digestion for twelve hours, with occasional shaking, the solution of ferrous chloride, which should be nearly free from copper, is carefully decanted off from the residue. The latter containing in addition to the spongy deposit of

copper, all the negative elements of the iron, carbon, silicon, sulphur, and phosphorus, is repeatedly washed with distilled water. The turbid washing-waters are filtered, and the filter is dried and incinerated. The residue in the flask is oxidised by the gradual addition of strong nitric acid, and finally by the application of heat. When the reaction is over it is rinsed into a capsule. The ash of the filter is then added; the solution is evaporated to dryness in the water-bath to eliminate silica, the soluble portion is filtered from the carboniferous silica, and the latter is purified by fusion with potassium-sodium carbonate, and again separated with nitric acid. The phosphoric acid in the second filtrate from the silica is precipitated by molybdic solution, and this precipitate is added to the main phosphoric precipitate. The deep blue filtrate from the carbon containing silica, which contains the main bulk of the phosphoric acid, is treated with molybdic solution in the usual manner. If the solution of molybdenum, prepared according to the formula of Lipowitz with ammonium tartrate, is used in presence of copper, the phosphoric acid is thrown down imperfectly or not at all.

Weyl's Method of Determining Carbon in Iron and Steel.—S. C. Jutsum.—From the CHEMICAL NEWS.

Determination of Silicon in Crude Iron.—T. N. Brown and P. W. Shimer.—From the CHEMICAL NEWS.

Condition of Silicon in Bessemer Steel.—L. L. De Koninck and A. Ghilain.—The particulars of this memoir are not given.

Presence of Nitrogen in Iron and Steel.—A. A. Allen.—From the CHEMICAL NEWS.

Detection of Glucose in Cane-Sugar.—P. Casamajor.—The author lixiviates the sample with a saturated solution of glucose in wood-spirit at 50 per cent, which easily takes up cane-sugar. The residue is washed with wood-spirit at 98.5 per cent, dried, and weighed.

Determination of Sugar in the Juices of the Sorghum Plant.—P. Collier.—We purpose returning to this memoir.

Determination of Chlorides in Urine.—M. Salkowski.—Volhard's process admits of direct application to the specimen, and gives satisfactory results.

Determination of Nitric and Nitrous Acids in Urine.—F. Röhmman.—The process of Schulze, which consists in liberating the nitric acid, reducing with ferrous chloride, collecting and measuring the nitric oxide formed, gives satisfactory results. For the determination of nitrous acid, Trommsdorff's process for its determination in water was somewhat modified.

Quantitative Determination of Urine.—E. Ludwig.—The urine is mixed with ammoniacal solution of silver and magnesia mixture. The precipitate, containing all the uric and phosphoric acids, is filtered off, washed with ammoniacal water, decomposed with a hot ammoniacal solution of potassium sulphide. Potassium urate is formed, and remains in solution. Filter, acidulate slightly with hydrochloric acid, and concentrate on the water-bath down to a few c.c. The uric acid which separates out on cooling is collected on a filter of glass-wool, washed with water, dried at 110°, and freed from sulphur by washing with carbon disulphide and afterwards with ether.

Approximate Detection of Phenol in Urine.—A. Cloetta and E. Schaer.

Modification of Pettenkofer's Reaction for the Bile-Acids.—E. Drechsel.—The author recommends phosphoric acid in a syrupy solution to be added, instead of sulphuric acid, to the concentrated solution of the alkaline salts of the biliary acids.

Isolation of Alkaloids.—A. H. Allen.—From the *Analyst*.

Meta-phosphoric and Hydro-ferrocyanic Acids as Reagents for Albumenoids in Urine.—The use of the former acid is due to Grigg (*British Medical Journal*).

Hofmeister proposes to substitute hydro-ferrocyanic acid for the mixture of acetic acid and potassium ferrocyanide.

Poisonous Principle of *Illicium religiosum*.—J. F. Eykmann.—The body in question appears to be free from nitrogen.

Detection of Colchicine.—J. Hertel.—The author, after extracting the object in the usual manner, treats it again with the strongest alcohol.

Certain re-determinations of atomic weights, given at the end of this issue, have been already noticed in the CHEMICAL NEWS.

Die Chemische Industrie.

Vol. 5, No. 5.

This issue, in addition to specifications of patents, contains a long essay on the German patent law in reference to chemical industry, by Dr. Relig.

Revue des Industries et des Sciences Chimiques et Agricoles No. 55, 1882.

Disinfection and Agricultural Utilisation of Blood (Continuation).—As the safest and most economical procedure the author recommends coagulation with ferric sulphate. The quantity of blood yielded by an ox is estimated at 20 litres, whilst a sheep yields only 2.

Purification of the Waste Waters of Manufactories (Continuation).—The authors discuss the treatment of the waste waters from wool-washing, as at Roubaix and Tourcoing. They recommend that the waters of the Esplanade, the sewage river of those towns, should be impounded at a convenient place, and treated with ferric chloride in the proportion of 200 c.c. per cubic metre, and turned into a settling-tank holding 1200 cubic metres. They propose to make use of filter-presses in freeing the deposit from water.

Disinfection of Alcohol by Electrolysis (Concluded).—MM. Naudin and Schneider.

No. 56, 1882.

Phosphoric Acid in the Arable Soils of the North.—In the alkaline or neutral soils of the north bone-black and fossil phosphates give but very poor results, whilst the same manures used in the acid soils of Bretagne and the Vendée have done wonders.

Note on the Composition and Analysis of "Dégras."—F. Jean.—In the process for preparing so-called chamois leathers a considerable amount of fatty matter remains as a by-product and is sold under the name of "dégras" to curriers, who use it for rendering ordinary leathers supple.

Means of Reducing the Production-Cost of Wheat by the Judicious Use of Manures.—H. Joulie.—The author recommends the substitution of good for inferior varieties, sowing by drill instead of broadcast; greater care in the destruction of weeds; reaping in suitable weather; threshing by machinery to prevent the waste of grain; deep cultivation, which secures the plants from drought and excess of moisture; and above all the judicious management of manures.

Chemical Manures Applicable to the Sugar-Cane.—E. Riffard.—In this extensive memoir the author recognises the eminent services which M. Georges Ville has rendered to agriculture by giving an impulse to the use of chemical manures. The sugar-cane requires manures rich in phosphoric acid and in nitrogen in a state ready for assimilation. In an experiment made on these principles the yield was at the rate of 356,000 kilos. of sugar per hectare.

Cosmos Les Mondes.
No. 6, June 10, 1882.

Observations on a Paper by MM. Bartoli and Papasogli entitled "Synthesis of Several Organic Compounds by means of the Electrolysis of Water, and of Acid, Alkaline, and Alcoholic Solutions with Electrodes of Coke.—D. Tommasi.—The authors above named state in their memoir, read before the Academy of Sciences May 15th, 1882, "The combination of electric oxygen with carbon is a fact which we have observed in 1879. We are surprised to see this fact published by M. D. Tommasi (*Comptes Rendus*, 1881, p. 790)." The latter *savant* writes—"Immediately after the first memoir, published in the *Nuovo Cimento* (Série 3, vol. iii., Nov., 1880), I addressed a letter to the editor, stating that in 1879, whilst studying the electrolysis of fused ferric chloride with coke electrodes, I had observed that the positive electrode was disaggregated and resolved into dust, whilst one part of the carbon combined with the chlorine. I afterwards added that I proposed to submit to electrolysis formic acid, or a formate, using electrodes of coke, in order to obtain new compounds richer in carbon." This letter was reproduced in several Italian journals, but MM. Bartoli and Papasogli did not think it their part to reply. Now, after the lapse of more than a year, they raise the question of priority before the Academy.

Theory of Electric Conductivity.—M. Pilleux.—The continuation of a mathematical paper, not capable of useful abstraction.

MISCELLANEOUS.

Dangerous Device in Shape of a Cigar Lighter.
—The following letter to the *New York Public Ledger* should receive attention as a warning. A sample of the dangerous thing has been tested at that office:—Mr. Editor,—As I stepped from the platform of a car this morning (corner of Seventh and Filbert Streets) I came upon a motley crowd, listening to the harangue of a bright fellow, who entertained his audience somewhat after this manner, "Only five cents. I offer you, gentlemen, something entirely new—a new kind of cigar-lighter. Cut off a small piece (about the size of a pin's head), place it upon a cigar or the contents of a pipe, as I do now, apply a drop of water, and it will at once take fire. We generally use water to *put out fire*, but here I will use it to make a fire," and then, dipping the pointed open knife into the gutter, the orator touched with it the bit of cigar-lighter lying upon the tobacco, and, presto! it took fire almost immediately, and burned with an intensely yellow flame. The vendor continued, "Once kindled, the flame will not go out till your pipe is lighted. Only five cents, who'll take the next?" The writer of this "took the next," with the view of examining the contents of the vial and reporting to you. The vial (an "11th homœopathic vial," covered with marble paper), contained several very small sticks of the metal sodium. Little did Sir Humphrey Davy imagine when he made his brilliant discovery of the alkali-metals, that ere the close of the century one of them would be hawked about the streets to light cigarettes and pipes. Insurance men can tell a sorrowful tale of the loss of life and property caused by the household use of friction matches. But what if papa should leave within reach of the children metallic sodium, a material that must always be handled with great care, even by those best acquainted with its properties. I trust that you will give the above immediate publicity, that people throughout the country, being forewarned, may leave the "new cigar lighter" severely alone, and that our efficient Mayor may, if possible, prevent the retailing of metallic sodium in the streets of Philadelphia.—Yours, &c., R. A. FISHER, Consulting Chemist, No. 2239, St. Alban's Street.

NOTES AND QUERIES.

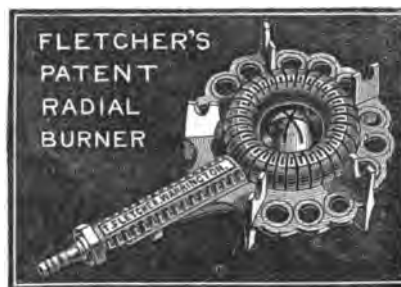
* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Free Acid.—Wanted particulars of a reliable method (volumetric) of ascertaining the percentage of free acid in mother-liquors or in sulphate alumina.—WIDNES.

TO CORRESPONDENTS.

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THE CHEMICAL NEWS

AND
JOURNAL OF PHYSICAL SCIENCE.

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ANALYSIS BY JOHN PATTINSON, ESQ.

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THE CHEMICAL NEWS

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21 JUL 82

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.

By J. W. MALLET, F.R.S.,

Professor of Chemistry in the University of Virginia.

(Continued from p. 16.)

Third Series of Experiments.

Preparation of Pure Metallic Aluminum.—A further supply of pure aluminum bromide having been made as above described, it was used to prepare metallic aluminum by reduction with sodium.

With a view to render the bromide more manageable while in contact with the air, it was decided to unite it with an alkaline chloride, as the aluminum and sodium chloride is used in the ordinary process of Deville, and in order to keep down the melting-point, a mixture of both potassium and sodium chlorides was employed. The two alkaline salts were separately purified, carefully tested, and well dried in platinum vessels, mixed in the proportion of one molecule of each, the mixture fused in lots of about 250 grms. in a platinum dish over a gas furnace, poured out into another such dish standing on a block of cold iron, the thin cake gently crushed to a coarse powder while still warm in a mortar of hard glazed porcelain (from which, it was afterwards proved by examination, no silica was taken up), and the pulverised product kept until needed in a well stoppered bottle. Separate portions of the purified aluminum bromide having been in the last distillation collected in tared glass flasks and weighed, a quantity of the above mixture of alkaline chlorides was weighed off for each corresponding to 1 molecule $(K+Na)Cl$ for 1 molecule $AlBr_3$, and the flask having been heated until the bromide was fused, the potassio-sodic chloride was cautiously added. Very marked rise of temperature occurred, so that in a first attempt, using considerable quantities of the materials and mixing them abruptly, since such an effect had not been foreseen, the flask was violently cracked, and torrents of aluminum bromide vapor were driven off. This evolution of heat is interesting as evidence of chemical combination taking place, not only between two chlorides or two bromides, but between a chloride and a bromide. The fused mass was on cooling crushed to small fragments and coarse powder and preserved in a well-stoppered bottle. The precaution was not omitted of testing for any evidence of impurity derived from the flasks or mortar, but with negative result. The material thus prepared did not fume in the air, was sufficiently slow in taking up atmospheric moisture to be managed without difficulty, and fused on re-heating to about $130^{\circ}C$. The sodium to be used in decomposing it was in large ingots, which when needed were wiped to remove naphtha, the outer crust cut off with a knife, the large pieces roughly weighed, and the proper quantity rapidly cut up into small fragments without again moistening with naphtha.

The great difficulty in the way of obtaining pure metallic aluminum consists in obtaining crucibles of suitable material, especially such as shall not yield either iron or silicon. M. Tissier* seems to have been more fortunate than I in the use of carbon vessels. The crucibles of hard carbon which I had on hand, purchased in Germany, contained both the above-named impurities, which were taken up in no small quantity by the aluminum; and I failed in sundry attempts to make crucibles of purer carbon, or to

use this substance as a lining, the carbon either burning away, crumbling up, or permitting the fused materials to pass through its pores or through cracks in the mass. I at last succeeded in adapting to my purpose alumina itself, sufficiently cemented together by sodium aluminate. I was indebted to Mr. Henry Pemberton, Vice-President of the Pennsylvania Salt Manufacturing Company at Natrona, Pennsylvania, and to Mr. W. N. Richard, of the same works, for an abundant supply of aluminum hydrate, such as is thrown down by a stream of carbon dioxide from solution of sodium aluminate in the process of making soda from cryolite. This was not absolutely free from iron, but one lot contained traces only of this metal, insufficient, as it turned out, to contaminate the aluminum to be made in contact with it. The hydrate was strongly heated in well-covered crucibles until it ceased to give off water; the alumina which was left required then to be guarded from the air, as it readily took up moisture again. All attempts to use it mixed with water and any unobjectionable cementing material to a plastic mass failed from excessive shrinkage and crumbling, but by mixing it in the dry state with dry sodium aluminate better results were obtained. The sodium aluminate had to be specially prepared, as that made (for soap boilers' use) at Natrona from cryolite contained too much iron. The dry mixture was pressed into wooden moulds, and three or four crucibles thus made having been very slowly and cautiously heated up in a gas furnace, stood fairly the necessary temperature of the reduction of aluminum, although they were very fragile. On the whole, however, it was found best to use a highly aluminous Beaufaye crucible, with a thick lining of this mixture of dry alumina and sodium aluminate well rammed in and very gradually heated. There were some failures from cracking of the crucibles or linings, and whenever the slightest contact of the metallic aluminum with the outer crucible occurred, silicon and generally iron were sure to be found in the metal. With successful prevention of this by an adequately thick and perfectly continuous lining there was much difficulty in securing a sufficiently high temperature in the interior, since the conducting power for heat of the alumina linings seemed to be quite low. This led to much loss of sodium by combustion, and but a very small yield indeed of really pure aluminum was secured. When the crucible had been heated up ready for the reduction, a small quantity of the pulverised mixture of potassium and sodium chlorides was thrown in; soon afterwards the aluminum bromide (which had been fused with the alkaline chlorides) with the proper quantity of sodium was introduced, and as soon as the violent reaction was over a further portion of the mixed alkaline chlorides.

Only the large, well-fused globules of aluminum were picked out; these were re-fused once or twice before a blowpipe flame upon a support of alumina, to free them from any possible remains of the flux; any trace of oxide was detached by acting slightly upon the surface with pure hydrochloric acid, and the globules were then well washed with water, and dried by a gentle heat. Specimens cut from different portions of the globules were carefully tested, particularly for silicon, iron, sodium, and potassium; and a sufficient quantity of the metal for the intended experiments was found to yield no appreciable trace of impurity. The surface of the specimens to be used which had touched the cutting pliers was again cleansed by acid and water. This pure aluminum did not differ much in physical character from the ordinary metal of commerce; it seemed, however, to be somewhat whiter, was distinctly softer, and had a little higher density, the mean of three closely-agreeing determinations made at $4^{\circ}C$, giving the number 2.583 as referred to water at the same temperature.

* Aside from the question of expense there is some advantage in using aluminum bromide for making the metal, on account of the low melting-point of the sodium bromide which is left. Carnelley's recent determinations (*Chem. Soc. Jour.*, July, 1878, pp. 279, 280) make the melting-point of sodium bromide $703^{\circ}C$, while that of the chloride is 772° , and that of the fluoride above 902° .

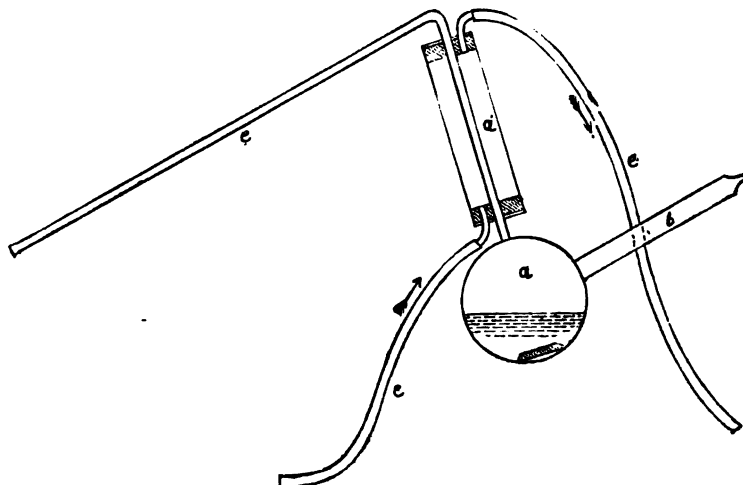
Production of Hydrogen by Aluminum, and Measurement of the Gas.—Details of Method used.—The pure metal was used for the determination of its atomic weight by acting upon a known weight of it with a strong solution of sodium hydrate and determining the amount of hydrogen evolved. The advantage of using an alkali rather than hydrochloric acid, as in Terrell's experiment above quoted, lies in the non-volatility of the former, only vapour of water having to be separated from the hydrogen, while sulphuric acid is not available on account of the resistance to its action of aluminum. In 1863 Fr. Schulze* proposed to measure the volume of hydrogen given off by the action of an alkaline solution on commercial aluminum as the means of approximately deciding on the comparative purity of different specimens. The nature of the reaction was established by preliminary experiments, which proved to me that normal sodium aluminate alone is formed, so that each atom of aluminum liberates three atoms of hydrogen. The sodium hydrate was prepared from metallic sodium, and was used in the form of a solution so strong as scarcely to lose a sensible amount of water by the passage through it of a dry gas at common tempera-

narrow part of the flask it was necessary to note in advance roughly the prevailing temperature and pressure, and to take advantage of a time when these were not undergoing much change. The level of the mercury having been noted on the millimetre scale, the corresponding volume was afterwards determined by calibration with mercury, weighed in portions of about half a kilogramme.

The little piece of apparatus used for the solution of the aluminum is shown in fig. 2, in which (a) represents a glass bulb of about 65 m.m. diameter; (b) a tube connected therewith, originally open at both ends, and about 12 m.m. diameter and 175 m.m. long, but afterwards reduced in length to about 100 m.m. by drawing off and sealing, as shown in the figure; (c) is the much smaller tube for carrying off the gas produced; (d) is a water jacket like that of the common Liebig's condenser, formed by a piece of larger tube surrounding the ascending limb of (c), and put in place before (c) was bent; while (e, e) represent small india-rubber tubes for circulating a current of water through (d).

Each experiment was made as follows: The proper quantity of strong solution of sodium hydrate, its volume

FIG. 2.



ture—such an alkaline solution, so far as strength is concerned, as would be used to absorb carbon dioxide in an organic analysis. The quantity taken for each experiment was but a few cubic centimetres, and but little beyond the exact amount required for the solution of the metal; a small excess was, however, always allowed, so that the action might not become very languid towards the end. This strong alkaline solution was prepared with water which had been boiled to expel air, and the solubility in it of hydrogen was ascertained to be so small that any correction on this account would have fallen within the limits of inevitable error, and might be safely neglected.

To secure accurate measurement of a somewhat large volume of hydrogen, two stout flasks were selected, one holding about a litre and the other about half as much, and with narrow necks of rather more than usual length; and on the necks a simple millimetre scale was marked. One of these flasks having been carefully filled with mercury and inverted over the mercurial trough, the hydrogen was collected in it, such a quantity of aluminum being used in each experiment as previous trials had shown would yield gas enough to bring the level of the mercury within the range of the scale on the neck. To thus obtain such a volume of gas as could be accurately measured in the

accurately measured, having been introduced into the bulb by means of a little tube funnel passed through (b), taking care to leave the surface of the latter clean, the aluminum (usually in a single piece of elongated shape) was passed through (b), held nearly horizontal, so that the metal did not slip down into the bulb, but rested 40 or 50 m.m. from it. (b) was now drawn off and sealed with a well-rounded end. The bulb was touched for a moment or two with the hand, so as to expel a very little air, and the outer end of the small tube (c) was introduced into the mercury of the trough, taking care that (b) was still kept in such a position as to prevent the aluminum coming in contact with the alkaline solution. After a sufficient lapse of time for the apparatus to have acquired the temperature of the room, the barometer and thermometer and the difference of level of the mercury in the trough and in (c) were read off;* so that, knowing the volume of alkaline solution introduced and of aluminum (the latter from its weight), calibration of the bulb and tubes after the experiment was over completed the data necessary to determine the volume of air which the apparatus contained at the beginning. The aluminum was now made to slide down into the bulb, the end of the gas-delivery tube (c) having been brought under the mouth of

* Fr. Schulze, *Die gasvolumetrische Analyse*, S. 28, quote in V Wagner, *Jahresbericht*, u. s. w., 1864, S. 23.

* All readings were of course made from a distance with the aid of a small telescope.

the measuring flask. Over-rapid evolution of hydrogen and any considerable rise of temperature was prevented, partly by tilting the bulb so that the little piece of aluminum rested against one side and exposed but a part of its surface to the action of the liquid, and partly by cooling the outside of the bulb with water; while, on the other hand, it sometimes became necessary to gently warm the liquid towards the end of the experiment. To guard against more than traces of aqueous vapour being carried away with the hydrogen, a current of ice-water was kept up through (d). As soon as the last of the aluminum had disappeared, leaving the liquid quite clear, (c) was brought up into a nearly vertical position, and the apparatus left to itself until the temperature of the room had been attained. The barometer and thermometer, height of mercury in (c) above that in trough, and level of mercury in neck of measuring flask (after the last traces of moisture had been removed from the hydrogen by means of a stick of caustic potash), with its height above that in trough, were now read and recorded. Lifting (c) straight up from the trough, the mercury in this tube was got out by running a wire up and down in it, and inverting it, the whole of the remaining space in (a), (b), and (c) was filled up with alkaline lye of the same strength with that already contained, this liquid being run in from a graduated burette through a slender tube funnel, and the volume used noted, so as to show how much liquid had been already present. The apparatus being now emptied, washed out, and calibrated (with water, instead of mercury, on account of the difficulty of getting the interior quite dry), the volume of gas remaining in it at the close of the experiment was had from the difference between the total capacity (to the level of the mercury in (c)) and the volume of the liquid which the bulb had contained at the close of the experiment, these taken together with the data for pressure and temperature.

On account of slight rise of temperature during the solution of the metal, the volume of hydrogen left in the bulb and tubes was always less than the air in the same at the beginning; and, after reduction to normal temperature and pressure, the difference had to be subtracted from the volume of gas collected in the flask.

In order to connect the weight of the aluminum with the weight of the hydrogen, the latter being obtained from its observed volume and Regnault's determination of its density, it was necessary that the weight of the metal should be absolute, or in terms of equal value with those used in Regnault's researches; hence, as has been already stated, the weights used were such as had had their real value determined, and the precaution of double weighing was applied. The quantities of metal used being small, the centre of gravity of the balance-beam was so adjusted as to give great sensitiveness.

In calculating the weight of the hydrogen from its volume, the difference in the value of the force of gravity at Paris and at the University of Virginia had to be taken into account. In view of the difference of latitude and elevation above the sea this constant is, in C.G.S. units,

For Paris	.. ..	980.94
For University of Virginia	.. ..	979.95

and, applying the difference in nominally normal pressure at the two places, Regnault's value for the weight of a litre of hydrogen at 0° C. and 760 m.m., 0.089578 grm., becomes 0.089488 grm.

In the experiments made in this way the only assignable cause of constant error, tending to affect in a particular direction the atomic weight reduced from them, seems to be the retention in solution of traces of hydrogen by the alkaline liquid in the bulb. The tendency of this is, of course, to make the atomic weight of aluminum appear greater than it should be, but I am satisfied that the possible extent of such error must be excessively minute, inappreciable within the limits of error of observation.

Direct Results of First Set of Third Series of Experiments.—The results obtained were as follows:—

A.—Hydrogen by volume at 0° C. and 760 m.m.

I.—0.3697 grm. of Al gave 458.8 c.c. = 0.04106 grm. of H.	
II.—0.3769 " " 467.9 " = 0.04187 " "	
III.—0.3620 " " 449.1 " = 0.04019 " "	
IV.—0.7579 " " 941.5 " = 0.08425 " "	
V.—0.7314 " " 907.9 " = 0.08125 " "	
VI.—0.7541 " " 936.4 " = 0.08380 " "	

Second Set of Experiments of Third Series.—Hydrogen Collected and Weighed as Water.—*Details of Method used.*—As the collection and accurate measurement of larger quantities of hydrogen would be difficult from the great weight of mercury to be dealt with, while it seemed desirable to repeat these experiments with a larger amount of aluminum, an arrangement was adopted for burning the hydrogen and weighing it as water.

A bulb like that described above was used for the reaction between the aluminum and solution of the sodium hydrate, another small tube (which may be designated as (x)) being connected, however, with the bulb, for the purpose of sweeping out air at the beginning of the combustion and the remainder of the hydrogen at the end by a current of other gas. The gas from the delivery tube (c) was carried through a series of four drying tubes, containing in the former two pumice stone soaked with pure sulphuric acid of full strength, and in the other two well dried asbestos and loose woolly phosphorus pentoxide; thence it passed through a long combustion-tube, filled for the first two-fifths with pure, finely granular cupric oxide, which had been recently ignited, and for two-fifths more with turnings of electrolytic copper oxidised on the surface, while the last one-fifth of its length remained at first unoccupied, to be filled later as will be described; the vapour of water being finally collected beyond this combustion-tube in a single light drying-tube of calcium chloride, one of sulphuric acid on pumice, and one of phosphorus pentoxide.

The whole of the apparatus having been put together, with the exception of the three final drying-tubes, for which at first a single unweighed calcium chloride tube was substituted, with sodium hydrate solution in the bulb, and metallic aluminum in the tube (b), a slow stream of carefully purified and well dried air was passed through from (x) for some time, while the combustion-tube was heated to low redness. Having allowed it to cool down to the temperature of the room, the stream of air from (x) was replaced by one of dry nitrogen; a plug of soft copper turnings with bright unoxidised surface was introduced into the further end of the combustion-tube, so as to fill up the unoccupied fifth of its length, and it was again brought to and kept at a red heat. After the nitrogen had passed through at this temperature for about twenty minutes, the three drying-tubes for the collection of the water to be formed, having been standing for some time in the balance case, were accurately weighed, and connected with the further end of the combustion-tube, the previously used and unweighed calcium chloride tube being removed. The tube (x) having been closed, the tube (b) was now tilted so as to make the aluminum slip down into the alkaline liquid, and as in the experiments already described, the rate at which the hydrogen was evolved was controlled by inclining the bulb so as to vary the extent of surface of the metal attacked, and by cooling the outside of the bulb with water.

As soon as the metal was all dissolved, nitrogen was again introduced by (x) to sweep out the remaining hydrogen, limiting the quantity of the former gas to such an amount as was thought necessary for this purpose. This nitrogen was then in turn replaced by pure and dry air, which was passed through the apparatus until the surface of the copper which had been reduced was reoxidised, this being done to avoid any risk of occluded hydrogen being retained, while the nitrogen had served to obviate the danger of explosion. The drying-tubes were then finally removed from the further end of the combustion-tube, and weighed after exposure to the atmosphere of the balance case long enough to permit the surface of the glass attain-

ing a constant condition. In both weighings the reduction to equivalent weights *in vacuo* was duly attended to, the weights and densities of all the materials making up the drying tubes and their contents having been previously ascertained. The last tube of the set was weighed separately, as was the last of the drying-tubes connected with the reaction bulb, and it was found that, there being no increase of weight on the part of either of them, the absorption of aqueous vapour was sensibly complete.

Although all the precautions I could think of were taken in these experiments, the well known difficulty of absolutely excluding moisture, of which every joint to the apparatus becomes a possible source, so that in ordinary organic analysis the amount of hydrogen found may be expected to come out rather above than below the truth, leads to the suspicion that such constant error as may have been involved tended in this direction, and if so that the resulting atomic weight would be made to appear somewhat too low. The extent of error from this cause, however, if it existed at all, must have been extremely small.

Direct Results of Second Set of Experiments of Third Series.—The results of these last experiments were—

B.—Hydrogen weighed as water.

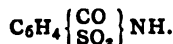
I.—2.1704 grms. of Al	gave 2.1661 grms. of H ₂ O.
II.—2.9355 "	" 2.9292 " "
III.—5.2632 "	" 5.2562 " "

(To be continued.)

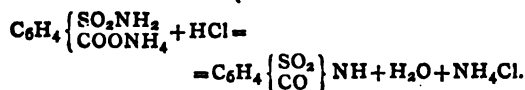
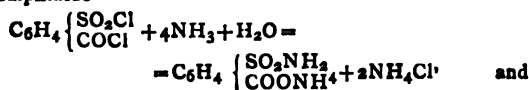
CONCERNING PHTHALIMIDE.

By M. KUHARA,
Fellow in Chemistry, Johns Hopkins University.

In a paper on the oxidation of ortho-toluene-sulphamide* it has been shown by Remsen and Fahlberg that, when ortho-sulpho-benzoic acid is treated with phosphorus pentachloride and ammonia, it is converted into benzoic sulphinide,—



It is probable that the normal chloride of the acid is first formed, and that when this is treated with ammonia the ammonium salt of sulphamine-benzoic acid is formed, which when treated with hydrochloric acid yields the sulphinide—



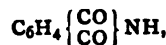
It seemed probable from a consideration of these reactions that phthalic acid when treated in a similar way would yield phthalimide, and at the suggestion of Prof. Remsen, I have made some experiments in the direction indicated.

Phthalyl chloride was made according to the directions of Ador,† by boiling phthalic acid (1 mol.) with phosphorus pentachloride (2 mols.) and a little oxychloride. On treating this with aqueous ammonia it passed into solution, and now on adding hydrochloric acid a bulky precipitate was produced. This dissolved easily by heating; on cooling, a mixture of white scaly crystals with a minute quantity of fine needles was deposited, while on still further concentrating the mother-liquor phthalic acid crystallised out. By re-crystallising the mixture from alcohol, beautiful transparent rhombohedral crystals were obtained,

and from the mother-liquors the needle-shaped crystals mentioned above were deposited. The rhombohedral crystals, which were obtained in larger quantity than the needles, were analysed:—

- I. 0.2 grm. gave 14.74 c.c. N after corrections.
II. 0.196 grm. gave 14.78 c.c. N after corrections.

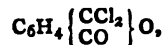
A substance of the formula—



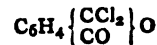
that is of the formula of phthalimide, requires 9.52 per cent N, while the quantities found correspond to 9.21 and 9.42 per cent respectively.

The substance is, however, quite distinct from phthalimide. It is soluble in cold alcohol and water, more readily in boiling alcohol and water, while phthalimide is not soluble in cold alcohol and water. It melts without decomposition when heated, and sublimes in flakes. It dissolves in concentrated sulphuric acid and water, throwing down phthalic anhydride from the solution. It melts at 192°, the imide at 230°. It gives no precipitate with silver nitrate.

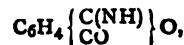
From the knowledge thus far gained it seems as though this substance must be regarded as an isomeride of phthalimide. According to von Gerichten* it appears probable that phthalyl chloride is either—



or a mixture of this substance with the normal chloride. If this view is correct, the formation of a substance isomeric with phthalimide might easily be accounted for. The action of ammonia upon a substance of the formula

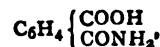


might give rise to a product of the formula—



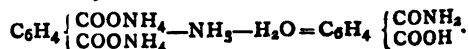
which would be isomeric with phthalimide. The formation of such a substance would be exceedingly interesting and its study attractive. I regret to say that, though I made repeated efforts to get possession of more of this product, they all failed, and I was obliged to give up its study. It is strange that in the first experiment just exactly the right conditions for its formation should have been found, and that these could not again be met with.

In the subsequent experiments it was found that when phthalyl chloride is treated with ammonia and hydrochloric acid phthalic anhydride is precipitated. It was also shown that when ammonium phthalamate is treated with hydrochloric acid phthalic anhydride is precipitated. When phthalyl chloride is dissolved in ammonia and the solution concentrated to a very small volume, phthalamic acid,—



is deposited. This was carefully compared with phthalamic acid prepared from phthalic anhydride, according to Marignac's directions,† and the two were found to be identical.

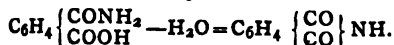
The connection known to exist between phthalic anhydride, phthalamic acid, phthalimide, and phthalyl chloride, would then lead to the conclusion that all these bodies have a similar structure. Phthalamic acid is made from ammonium phthalate by heating, and the only equation which will represent this reaction satisfactorily is the one commonly used—



* American Chemical Journal, 1, 426.
Annalen der Chemie, 164, 230.

* Berichte der Deutsch. Chem. Gesell., 13, 477.
† Annalen der Chemie, 42, 219.

Further, when phthalamic acid is heated it gives off water and is converted into phthalimide:—



It is possible, of course, to conceive of the formation of the isomeric substance,—

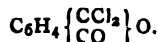


under these circumstances, but its formation does not appear probable. While, then, it is impossible to decide positively what the formula of phthalimide is, the probabilities are in favour of the one commonly accepted.

Now, when phthalyl chloride is treated with gaseous ammonia it is converted directly into phthalimide. The reaction takes place very easily, and is accompanied by a decided evolution of heat. The substance possessed all the properties of phthalimide as described by Laurent and Marignac. The yield was excellent; apparently almost quantitative. Assuming that phthalimide has the commonly accepted formula, the only way to represent this transformation of the chloride satisfactorily is by the equation—



But this leads to the view that the chloride has the normal structure, whereas, as was stated above, the experiments of von Gerichten indicate that the chloride is—



It is possible that a substance isomeric with phthalimide is formed when phthalyl chloride is treated with ammonia, and that this is then converted spontaneously into the imide.

A few derivatives of phthalamic acid were made, as this substance has been but very imperfectly studied. The only salts of the acid which have hitherto been prepared are those of silver and ammonium. In order to prepare the imide it was found most convenient to pass dry ammonia into a flask containing phthalic anhydride, slightly heated. A violent reaction took place, the mass instantly melting, and then soon solidifying again. The solid mass was essentially pure imide.

To an aqueous solution of phthalimide there was added an excess of baryta water, and the two boiled together. A current of carbon dioxide was then passed through the cooled solution, the precipitated barium carbonate filtered off, and the clear filtrate concentrated. The salt does not crystallise from an aqueous solution, the latter finally becoming syrupy in consistency and remaining so even after long standing. If alcohol be added to the concentrated aqueous solution the salt is thrown down as a white amorphous powder, being entirely insoluble in alcohol. This was filtered off, dried, and analysed:—

0.1135 grm. precipitated barium salt gave 0.057 grm. BaSO_4 .

Calculated for
 $\left(\text{C}_6\text{H}_4 \left\{ \begin{array}{l} \text{CONH}_2 \\ \text{CO}_2 \end{array} \right\} \right)_2\text{Ba} \dots 29.46 \text{ per cent Ba.}$
 Found . . . 29.47 " "

Potassium Phthalamate, $\text{C}_6\text{H}_4 \left\{ \begin{array}{l} \text{CONH}_2 \\ \text{COOK} \end{array} \right\}$.—This salt was prepared by the gradual addition of a very dilute solution of potassium sulphate to the solution of the barium sulphate. After filtering off the precipitated barium sulphate the solution was left to evaporate slowly over sulphuric acid. After several days very fine, silky, transparent needles crystallised out. It is easily soluble in alcohol and water. It gives off ammonia when boiled with potassium hydroxide, and hydrochloric acid throws down phthalic anhydride from its solution.

Copper phthalamate was prepared from the barium salt by precipitating with a solution of copper sulphate. It

does not crystallise, but gradually separates in the form of an amorphous powder.

Phthalamic is an exceedingly weak acid, and its salts are not well characterised compounds.*—*American Chemical Journal*.

ON THE DETERMINATION OF REVERTED PHOSPHATES.*

By THOMAS S. GLADDING, A.M.

(Concluded from p. 21.)

SERIES XIII.

Employing 1 grm. substance	P_2O_5 dissolved.	P_2O_5 undissolved.
" 2 "	10.06 per cent.	1.94 per cent.
" 3 "	9.85 "	2.15 "
" 4 "	9.65 "	2.35 "
" 5 "	9.43 "	2.57 "
" 5 "	9.02 "	2.98 "

The very slight and uniform decrease of reverted phosphoric acid, about 0.20 per cent for each additional grm. taken, up to the 5 grms. when the increase is a trifle larger, would certainly seem to show that every source of discrepancy but the third mentioned above had been obviated. When it is observed that in the last experiment 0.451 grm. of reverted phosphoric acid is dissolved by the 100 c.c. of citrate of ammonia solution at the temperature of 70° C. to 40° C., it certainly seems that nothing further could be desired as regards vigour of action upon the reverted forms. No other solvent suggested will approach the citrate solution in this important respect, when employed at the temperature here adopted.

But as regards the third cause of discrepancy it is very different. This cause lies in the very nature of things and cannot be overcome. No reagent can be found that will dissolve the strictly reverted phosphates and not affect the undecomposed rock present. Nor is it desirable that any such reagent should be found, nor would it be just to employ it in case it were possible to find it. The whole idea upon which the determination of reverted phosphates rests is that the solvent action of the liquids of the soil is stronger than that of pure water, and is closely imitated by the solvent action of the organic salts of ammonia. Now there is a certain percentage of raw phosphates that will always be taken up by this increased solvent power, and this percentage is practically and with justice considered equal in value to and reported as reverted phosphate.

The only difficulty that now presents itself is to so fix the amount of substance taken for analysis that the solvent action of the citrate solution upon the undecomposed rock shall dissolve such a percentage of this as shall when reported as reverted phosphate be a fair equivalent of its agricultural value. This conception here stated will be best illustrated by the accompanying diagram. 2 grms. of the five forms of raw phosphates were treated with 100 c.c. of citrate of ammonia solution at a falling temperature

* The fusing-point of phthalic acid has been the subject of considerable discussion, the last statement bearing upon it having come from E. Ador (*Annalen der Chemie*, 164, 239). Ador says the crystallised phthalic acid melts at 215°, and the powder of the same substance at 203°. The discrepancies in the statements on record seem to be due to the fact that when the acid is heated it is partly converted into its anhydride before its fusing-point is reached. The presence of the anhydride tends to lower the fusing-point, and this is the lower, the more anhydride there is formed. If the acid is heated slowly, or if it be used in the form of powder, more anhydride is formed and the fusing-point is lower. Some special experiments were made with the pure acid to test the correctness of this view. Small quantities were heated in U-tubes placed in paraffin baths at the temperature of 140° and 170°. In both cases anhydride was formed and the fusing-point of the acid considerably lowered. Under exceptional conditions the fusing-point of pure phthalic acid may be observed as high as 213°, but usually it will be found to vary considerably. To test the purity of the acid it is advisable to make the anhydride, and then crystallise this when pure, from water.—J. REMSEN.

70° C. to 40° C. for one hour, also two grms. of the reverted phosphates of iron and alumina containing 35.62 per cent of phosphoric acid. The latter was dissolved to a clear solution.

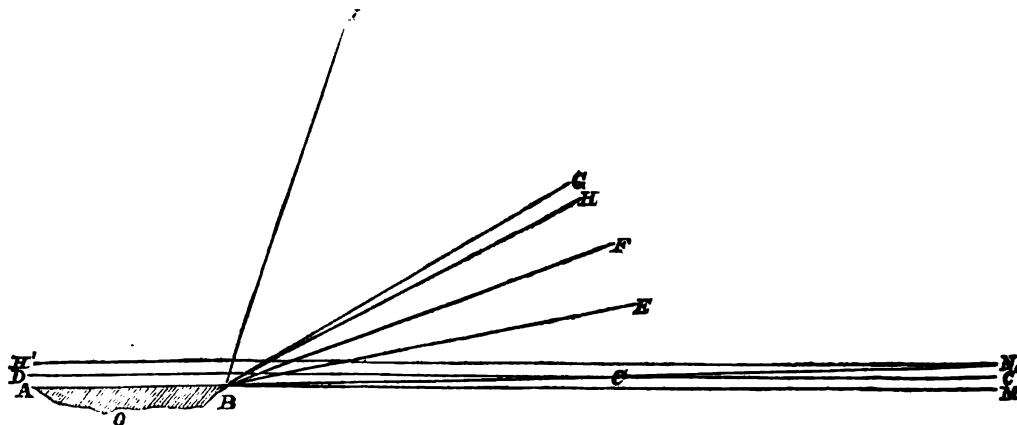
SERIES XIV.

Apatite ..	Phosphoric acid dissolved, 0.60 per cent
South Carolina rock ..	" 2.62 "
Bone Ash	" 3.15 "
Navassa	" 3.75 "
Curacao	" 7.50 "
Reverted phos. of iron and alumina	" 35.62 "

In the diagram use is again made of the figure of speech previously employed. AOB is the river bed, representing the phosphates soluble in water, completely covered by the line AM, the height of which represents the solvent power of water. The line BC represents the flats or the reverted phosphates lying just above the water, and slightly rising, since the different forms possess different degrees of solubility. The line DC' represents the solvent power of 100 c.c. of citrate of ammonia solution at the temperature 70° C. to 40° C. The lines BE, BF, BH, BG, and BI represent the banks rising at different angles, or the different raw phosphates, Curacao, Navassa, bone-ash, South Carolina rock, and

chemists regard its phosphoric acid as nearly all in the available form, and an analysis made by one chemist on the identical sample used in this work reports the presence of 18 per cent of reverted phosphoric acid. But the whole course of experiments given in this paper shows conclusively that it differs from the other raw phosphates only in degree of solubility, and is very far removed as regards this property from the true reverted forms, being, as shown in the diagram, based upon Series XIV., only $\frac{1}{4}$ as soluble at the best as the latter, and only about twice as soluble as Navassa rock and bone-ash.

It seems almost certain from the agricultural experiments described in the last edition of Johnston's "Agricultural Chemistry," on the use of finely ground raw phosphates, that all the phosphoric acid in such phosphates becomes ultimately soluble in the soil. The division of phosphates therefore into the three forms, soluble, reverted, and insoluble, will have reference only to the time required to render them available for plant use. Supposing, in the accompanying diagram, that the solvent action of 100 c.c. of the citrate solution represents the solvent action of the liquids of the soil for a certain period of time, as *e.g.* one season, upon the forms of phosphate there represented, it is evident that all the soluble and reverted would be available the first season, that raw Curacao would all be rendered available in something over



apatite here examined. These lines are all two inches in length, to represent the 2 grms. of substance taken. All of BC falls below DC or becomes soluble in the citrate solution, $\frac{1}{4}$ of BE, $\frac{1}{4}$ of BF, $\frac{1}{4}$ of BH, $\frac{1}{4}$ of BG, and $\frac{1}{4}$ of BI, calculating from 30, 30, 36, 27, and 42 percentages of phosphoric acid present in the five samples.

Now suppose 1 gm. of the above substances be taken to 100 c.c. of citrate solution. This proportion is the same as 200 c.c. citrate solution to the 2 grms. of substance taken in the diagram. The line DC will be raised to H'N, twice as far above the surface of the water. Twice as large an amount of reverted phosphates will be taken up, *viz.* BN, and at the same time nearly twice as large an amount of raw phosphates as shown in the figure. Thus repeating Series XIV., using, however, 1 gm. of substance, there were dissolved as follows:—

SERIES XV.

Apatite ..	Phosphoric acid dissolved, 1.06 per cent
South Carolina rock ..	" — "
Bone Ash	" 5.20 "
Navassa	" 6.20 "
Curacao	" 11.50 "

Attention is called to the nature of Curacao phosphate as brought out in this connection. Since by successive treatments with citrate of ammonia solution, or by employing a very small quantity for analysis, as $\frac{1}{4}$ of a gm., nearly all of this can be brought into solution, many

five seasons, the Navassa in eight seasons, and so on. The divisions, therefore, of soluble, reverted, and insoluble become indispensable as means of fixing commercial and agricultural values.

In conclusion, emphasis is laid upon the following points as brought out in this enquiry:—

I. While the line of division between the reverted forms and the original insoluble forms of phosphoric acid may be sharply drawn in the case of an extremely insoluble phosphate, like apatite, in the case of the more easily soluble natural phosphates the two great classes overlap, one the other. Whatever solvent therefore is used for determining reverted phosphates, the same will also dissolve a small percentage of the undecomposed phosphate that may be present; this percentage varying considerably according to the character of the insoluble phosphate. This percentage, representing as it does the comparative solubility which such insoluble phosphate possesses to the true reverted phosphates present, is justly considered as equivalent to an equal amount of the true reverted forms, and reported as such.

II. A slightly ammoniacal citrate of ammonia solution, alone of all the solvents that have been proposed, is a perfect solvent for all the forms of reverted phosphate, while at the same time not unduly dissolving the raw or insoluble phosphates present. Such a solution dissolves but a trace of the most difficult soluble form of phosphate known, *viz.*, apatite, and dissolves the other natural phos-

phates to a greater and greater extent as they approach in character the true reverted forms.

III. Neither the "Washington method" (method of Fresenius), nor the "Cincinnati method" can be relied upon to take up all the reverted phosphates that may be present.

IV. A modification of the method of Fresenius, consisting of the use of a higher temperature for the digestion, will meet all the requirements of the case, provided that the greatest care is taken to guard against acidity of the solvent and consequent excessive solution of the insoluble phosphates present. Whether the falling temperature of 70° C. to 40° C. as here explained, or a continuous temperature of 65° C. for 30 minutes, be used, there will be but slight if any differences in the results, provided that the solution of citrate be slightly ammoniacal, and the digestion be made in a closed flask. To the use of acid solutions of citrate, either acid at the beginning of the digestion or becoming acid during its continuance, are probably due, more than to any other cause, the discrepancies in this analytical process.

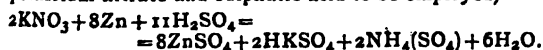
Laboratory of Stillwell and Gladding, New York.

ESTIMATION OF NITRIC NITROGEN.

By J. BOYD KINNAR.

So many methods for this purpose have been proposed which have failed in other hands to yield the results obtained by their authors that it is with much hesitation I submit the following process. But it has proved with me so accurate and convenient that I venture at least to offer it to the consideration of others more competent.

The idea of the reduction of nitric and nitrous acid and conversion of the nitrogen into ammonia by the action of zinc and an acid, was long ago suggested, but the results were found to be uncertain and incomplete from the partial production of lower oxides of nitrogen. The advantage, however, which would accrue from operating with a dilute acid and in the cold, instead of with an alkali, or strong acid, and with heat, is so great, especially in presence of organic compounds of nitrogen, that I undertook a series of experiments, with the view of either making the zinc and acid method more complete, or at least of ascertaining some definite ratios of error. Into the details of these it is unnecessary to enter. A comparison of the results showed at last that the method tended to greater accuracy the more the solution of the nitrates operated on was dilute, and that at a certain point of dilution the whole of the nitrogen was combined as ammonia. This point I have not yet precisely determined—possibly it may vary for different combinations. But for practical purposes it may be taken as one of nitrogen (nitric) in five thousand of water, though the reaction will often be found perfect in solutions of twice or three times this strength. The necessary proportions of zinc and acid are indicated by the equation (supposing potassium nitrate and sulphuric acid to be employed)—



But it is advisable to use at least a half more of sulphuric acid than is required by the formula, and the larger the surface of zinc the more quickly is the reaction complete. Hydrochloric acid answers as well, and iron might be substituted for zinc but for its liability to contain occluded nitrogen. When only a slight excess of acid is used the action is slow and the evolution of hydrogen trifling, but by employing a moderate excess of acid and nearly filling the vessel with granulated zinc, the evolution of gas is rapid, much heat is produced, and the conversion into ammonia is often complete in ten minutes. In all cases the process must be stopped by pouring off the acid liquid and washing the zinc before the acid is fully saturated.

Besides rapidity and simplicity another advantage is that in many cases the resulting ammonia may be at once estimated in an aliquot portion by the Nessler process. For this purpose care must be taken that the zinc and sulphuric acid are both pure, and that substances which give coloured iodides are absent. Lime and iron, which most frequently occur in ordinary analyses, may be previously precipitated by oxalic acid and potash. When the quantity of zinc dissolved is small the addition of the Nessler solution causes no precipitate, but when it does, the zinc may be first precipitated and re-dissolved by solution of potash. Very rapid and often sufficiently accurate determinations may thus be arrived at, but of course other methods of estimating the ammonia are equally available.

The reaction between the nascent hydrogen and the nitrates and nitrites appears to be quite without effect on organic nitrogen, so much so that the nitric acid in urea nitrate may be thus estimated without the urea being decomposed. The advantage of this in examinations of juices of plants, water, manures, need not be pointed out. When the quantity of the material available is small, it is also an advantage that the same solution may serve for the successive determination, first of the ammonia already formed, next (directly or by difference) of the nitric nitrogen, next of so-called "albumenoid ammonia," and lastly by combustion of the total nitrogen, without risk of results of each process overlapping each other, and thus giving too high a result.

July 5, 1882.

ON THE CAUSE OF THE BLUE COLOUR OF SAPPHIRE, LAZULITE, AND LAPIS LAZULI; THE GREEN OF EMERALD, AND THE PURPLE OF AMETHYST.

By Lieut.-Colonel W. A. ROSS, late R.A.

(1.) In the year 1871, at Mussooree in India, I attempted to obtain a blue colour by dissolving pure alumina to saturation in a borax bead before the blowpipe; and, after a fortnight's work, obtained a very pale blue bead, hard enough to scratch glass. But this experiment took me no further than the presumption that the blue colour of *sapphire* is due only to the 98 per cent of alumina, and not to traces of any supposed metallic oxide which it might contain.

(2.) Matters remained thus until the following year, when, being stationed at Woolwich with my battery, Professor G. G. Stokes did me the honour to witness some of my blowpipe experiments at that place, and eventually to read a paper upon the subject before the Royal Society (*Proc. Roy. Soc.*, vol. xx., p. 449). Among these experiments was one of the treatment of lime before the blowpipe in a bead of pure boric acid, which I found, besides forming transparent spherules or balls of calcium borate, "caused immediate turbidity over the whole bead;" and this phenomenon was supposed by me at the time to be explainable by the following hypothesis:—"The turbid part would appear to be an attempted solution of the lime by the boric acid; the clear part, a complete solution of the boric acid in the borate of lime." (*Proc. Roy. Soc.*, vol. xx., p. 464).

(3.) But I afterwards found (a) that *freshly calcined* lime afforded no turbidity whatever to the boric acid bead, but only a transparent calcium-borate ball within the bead, which, when boiled out of the bead by water, was invariably four times the weight of the calcined lime employed to make it; and (b) that *hydrated* lime, on the contrary, rendered the bead completely opaque with turbidity, and then afforded a ball only three times the weight of the hydrate of calcium; the calculation based on this differ-

ence in weight coinciding remarkably closely with that of the amount of water in calcium hydrate, as determined by the calculation of the chemical combining weights.

(4) It thus seemed impossible to doubt that the turbidity caused by the treatment of lime in boric acid before the blowpipe was due to the water contained in the lime, and not to the lime itself; and it was further remarked that, in calcining hydrated lime before the blowpipe, a strong orange-coloured flame was afforded, which ceased when the contained water was thus, in great part, eliminated.

(5.) I now found that the intense orange flame afforded by new platinum-foil rolled up and held in platinum tongs before the blowpipe, caused a precisely similar turbidity or opalescence in a boric acid bead upon which it was allowed to continuously impinge (which opalescent bead can be made to re-hydrate calcined lime), and by fusing (in 1873) some ounces of crystallised boric acid, which previously afforded perfectly transparent beads, in an open platinum dish for several hours over a table blowpipe, I obtained a considerable quantity of opalised or "hydrated" boric acid, which now exhales a curious smell of resin on first heating before the blowpipe.

(6.) I also also ascertained that when I dissolved pure alumina before the blowpipe in a bead of this opalised boric acid by means of the addition of a very small proportion of hydrate of potash, I obtained a pale blue or bluish bead with much greater rapidity and facility than by the experiment detailed in (1); but still the result was far from satisfactory.

(7.) Some years after this, having begun a series of experiments for the purpose of detecting traces of phosphoric acid in minerals by means of the colour afforded to their solution in boric acid and potash by tungstic acid (confirmed by Mylius in the *Berichte der Deutschen Chemischen Gesellschaft*, for June, 1880, page 1145), I purchased some American *wavellite* in London* for the purpose of experiment, and, upon treating its powder in an opalised or hydrated boric acid bead with a little hydrate of potash before the blowpipe for the purpose of dissolving it previous to the addition of the tungstic acid, I was astonished to find my bead become purple, then blue, and finally a brilliant green colour, without the addition of tungstic acid at all: and I soon found that no other phosphate besides aluminium hydrated phosphate (or *wavellite*) would thus afford coloured beads.

(8.) The next operation was to carefully examine my *wavellite*, which seemed very pure, occurring in the usual pale greenish radiated crystals, without any admixture of matrix. This I effected by treating its fine powder in pure boric acid before the blowpipe; adding potassium carbonate in order to remove the phosphoric acid as potassium phosphate; boiling the bead in distilled water; cautiously adding ammonia until there was no further precipitate; filtering off the residual alumina; and finally testing both residue and filtrate separately in pure boric acid beads before the blowpipe. In this way I could detect nothing but alumina and phosphoric acid.

(9.) Although no phosphoric acid has been detected, either in *sapphire* or *lapis lazuli*, still the equally blue *lazulite* is essentially an aluminium phosphate; and this very American *wavellite* possesses a greenish colour without any apparent cause, unless it be the large proportion of water which it contains; whilst pure phosphoric acid is well known to be one of the most deliquescent substances in nature.†

(10.) I now completed my preparations by baking my crushed *wavellite* for several days in an oven, when it became a pale grey colour. I also fused my potassium hydrate on aluminium plate before the blowpipe, because these measures seemed to concentrate the water the substances contained, and thus to cause the blue colour to

result more certainly and rapidly than with the raw material, with which a very fine green colour is more generally obtained. (Some beads enclosed, marked (c); one cut by Hunt and Roskell).*

(11.) To sum up: the materials for the production of these pyrological colours are as follow:—

(a.) A bead of opalised or hydrated boric acid.

(b.) Baked pure *wavellite*, or hydrated aluminium phosphate.

(c.) Fused potassium hydrate, to dissolve (b) in (a) (to be added very cautiously before the blowpipe).

(12.) I showed a pure blue stone thus made and set in a ring, to Dr. Tyndall in 1881, and a small bottleful of green stones to Sir W. Thomson at Swansea in 1880, at the British Association Meeting.

The colours thus producible by the blowpipe alone from these three colourless substances—hydrated aluminium phosphate, hydrated boric acid, and potassium hydrate—are, A, purple or "amethyst"; B, green; C, blue. Heintz proved that the colour of *amethyst* is not due to manganese or titanitic acid. The attribution of the green of emerald to a trace of chromic acid by some chemists is founded on a misapprehension, as solutions of chromium before the blowpipe are invariably pink when hot, but solution of emerald is not. Finally, it is obvious that when Gmelin found out the way to make artificial *lapis lazuli* by synthesis of its constituents, which are colourless, he was no nearer the cause of colour than Klaproth was when he found out the constituents of the mineral.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. No. 26, June 26, 1882.

Reciprocal Displacements of Acids Combined with Mercuric Oxide.—M. Berthelot. The author, in studying the salts of mercury, has observed certain facts relative to the displacement of acids,—facts very characteristic, because they show the conditions of coincidence or opposition between the ancient laws of Berthollet and the new thermo-chemical laws. It appears that the acids experimented with arrange themselves, from the thermic point of view, in the following order: Oxalic acid surpasses acetic acid, and is in turn surpassed by hydrochloric acid, whilst hydrocyanic acid prevails over all the others. Hence, according to thermo-chemical principles, oxalic acid ought to decompose mercury acetate; hydrochloric acid should decompose mercury acetate and oxalate, and hydrocyanic acid should in like manner decompose mercury acetate, oxalate, and chloride. Moreover, each of these reactions should be complete, or sensibly so. On the contrary, the laws of Berthollet indicate that acetic and hydrochloric acid combined with mercury oxide, should be equally displaced by oxalic acid on account of the insolubility of mercury oxalate—previsions of which the first is conformable and the second contrary to the former. Berthollet thought, besides, that in the case of two acids forming soluble salts each of them had in the reaction "a share determined by its capacity of saturation and its quantity," that is to say, that two acids employed in equivalent weights take each the half of the antagonistic base, an opinion contrary to the thermo-chemical previsions.

Use of Zinc-Coke Elements in Electrolysis.—D. Tommasi.—The author replies to M. Berthelot's objec-

* From Mr. Henson, Mineralogist of Fleet Street.

† Since then, I have been able to prove, by means of the assay balance, the presence and proportion of this "chemical water" in all alumina and silica.

* A pure blue bead, made by me from the same materials, has since been sent to the Editor. W. A. R.

tions to his last memoir (*Comptes Rendus*, June 5, 1882). He has shown that with two zinc-carbon elements and dilute sulphuric acid, a solution of potassium sulphate is decomposed when the decomposition could not be effected by means of two zinc-platinum elements in dilute sulphuric acid. This experiment has been repeated with solutions of potassium sulphate of different strengths, but no appreciable difference has been observed between the electrolysis of these solutions. The decomposition of potassium sulphate under the circumstances in question cannot be ascribed to the presence of foreign bodies in the coke, for even if it contained metallic substances this would lessen rather than increase the difference of potential at the ends of the circuit. As for the substitution of pure coke for platinum in a zinc platinum element with dilute sulphuric acid, M. E. Becquerel observed as far back as 1856, that the electromotive force of the element decreased instead of increasing. It has since been found that in elements with two liquids the substitution of coke for platinum either leaves the electromotive force of the element unaffected (Grove's or Bunsen's elements) or greatly increases them (bichromate elements). It does not appear more probable that the increase of the electromotive force of the carbon elements is due to the absorption of hydrogen or oxygen by the coke, since to obtain good results with such elements it is necessary that the coke contains in its pores a gas, e.g., carbonic anhydride, which may hinder or retard the polarisation of the positive electrode.

Silicium.—P. Schützenberger and A. Colson.—The authors have observed the formation of platinum silicide on heating to whiteness a platinum wire in the centre of a thick stratum of lamp-black free from silica. Hence silicium must have been transported from the walls of the crucible through a layer of lamp-black several centimetres in thickness. The addition of titanous acid in fine powder to the lamp-black arrests this transfer. A mixture of lamp-black and iron is ineffectual. Further experiments seemed to show that nitrogen plays a great part in the conveyance of the silicium.

Action of Potassium Bimolybdate upon Certain Oxides.—F. Parmentier.—On setting out with a mixture of corundum and potassium bimolybdate it is possible by lowering the temperature to form a double salt, aluminium potassium bimolybdate along with a more basic molybdate. Water dissolves the mixture, and gives rise to hydrated salts, which a large excess of water destroys, gelatinous alumina being precipitated. Analogous facts have taken place in the formation of certain minerals.

Action of Hydrogen Sulphide on Nickel Sulphate in Acetic Solution.—H. Baubigny.—(See page 17.)

The Alleged Compound NH_2 .—M. Combes.—M. Maumené has communicated to the Academy a memoir, in which he studies the action of permanganate upon ammonium oxalate. He asserts that there is produced in this reaction a new body, NH_2 or N_2H_4 . The existence of this compound (hydrazine) is theoretically not improbable, since its ethylic and phenylic derivatives are known. The author has repeated the experiments of M. Maumené with the following results: The carbonate which M. Maumené describes, if treated with hydrochloric acid, gives with platinum chloride a precipitate, the appearance and crystalline form of which are absolutely those of ammonium chloro-platinate. The analysis of this precipitate shows that it contains 1.96 to 1.90 per cent of hydrogen, whilst ammonium contains 1.80 per cent, and the body indicated by M. Maumené only 1.35. The aqueous solution of the supposed NH_2 , if saturated with hydrochloric acid and concentrated, gives crystals absolutely identical with those of ammonium chloride. Fractionated crystallisations have always given the same result. The analysis of this chloride shows 7.35 to 7.52 of hydrogen. Ammonium chloride gives 7.47, and the chloride of NH_2 only 5.71. In the reaction indicated nothing is produced but ammonia and carbonic acid.

Didymium.—B. Brauner.—Inserted in full as communicated by the author. (See page 16.)

Action of Oxygenated Water upon the Red Colouring-Matter of the Blood, and on Hæmatosine.—A. Béchamp.—Hæmoglobine and hæmatosine behave alike in contact with oxidisable bodies. Oxygen is disengaged correlatively. This is what Thenard ascertained for certain vegetable proximate principles. Thus sugar and starch in contact with concentrated oxygenated water evolve simultaneously carbonic acid and oxygen. It is clear that blood contains two agents capable of decomposing oxygenated water, the microzymas and hæmoglobine.

Gastric Juice.—P. Chapoteaut.—According to the author, pepsine is a compound of an albumenoid with an organic acid, the nature of which he hopes shortly to demonstrate.

Bulletin de la Société Chimique de Paris.
May 5, 1882.

Diazo-benzol Nitrate.—MM. Berthelot and Vieille.—Diazo-benzol nitrate is an explosive crystalline solid. Diazo-benzol is a nitrile, and the nitrate has been proposed as a primer. The authors have studied its formation-heat, its detonation-heat, and its combustion-heat with the density and the pressures developed in closed vessels. Diazo-benzol nitrate is as sensitive to a shock as mercury fulminate. If heated, it detonates with extreme violence at 90° , whilst mercury fulminate does not, under similar circumstances, explode below 195° .

Researches on Nitrogen Sulphide.—MM. Berthelot and Vieille.—This compound, like all the binary compounds of nitrogen except ammonia, is formed with absorption of heat. It is stable in moist or dry air, and may be repeatedly moistened and dried at 50° without appreciable alteration. It detonates under the hammer, but it is less sensitive to a shock than mercury fulminate or diazo-benzol nitrate. If heated, it explodes about 207° , a temperature bordering on the combustion-point of sulphur.

Communications from the Laboratory of the Chemical School of Mulhouse. 1. **On Certain Derivatives of Rosaniline.**—E. Noelting.—We know that the halogenous aromatic compounds do not possess the property of easily exchanging their halogen or of substituting their aromatic residue in other compounds,—a property which characterises the halogenous compounds of the fatty series. But if we introduce into the aromatic radical one or several groups NO_2 , the substance becomes more readily attackable, and the halogen is susceptible of being replaced. Thus ammonia is without action upon mono-chlorated benzol, $\text{C}_6\text{H}_5\text{Cl}$, but it easily yields dinitraniline with chloro-dinitro-benzol. In the same manner the aromatic chlorides are without action upon rosaniline, but their nitro-derivatives form with this base substitution-products which are colouring-matters, varying in shade from brown to maroon. The author observed this reaction five years ago, and hoped to render it industrial. Unfortunately the colours thus produced are costly, and identical shades may be more cheaply obtained by means of the azo-compounds, rocelline, bordeaux, &c. The chloro-nitro-derivatives which the author has studied are chloro-dinitro-benzol, obtained by the action of nitric and sulphuric acids upon mono-chlorated benzol; picryl chloride and the mixture of chloro-nitro-naphthalenes obtained by treating mono-chloro-naphthalene with a mixture of nitric and sulphuric acids. To obtain these colours we heat in a flask on the oil-bath for five to six hours, at from 180° to 200° , a molecule of rosaniline with a molecule of the chloro-nitro-derivative, e.g., chloro-dinitro-benzol with the addition of glacial acetic acid. The mass when cold is broken up and boiled with acidulated water to eliminate unattacked rosaniline. We then filter,

dry, and exhaust with benzol to remove an excess of chloride and a little resinous matter. The residue is the hydrochlorate of the new tinctorial base mixed with a certain quantity of carbonaceous matter. This salt is insoluble in water, but soluble in alcohol. The acetate dissolves also in water. The mass is exhausted with boiling alcohol with the addition of a little acetic acid, and the alcoholic extracts are poured into dilute soda, when the base is precipitated as a paste, which is collected. It is soluble in water acidulated with acetic acid, and may be at once applied in dyeing. Upon silk it produces shades of a violet garnet, approaching a maroon, and very fast as against light and acids. This compound is dinitro-phenylic rosaniline. Trinitro-phenylic and dinitro-naphthyl rosanilines are prepared in exactly the same manner. Phenylic rosaniline is easily sulpho-conjugated, but this is not the case with its nitro-derivative. Ordinary sulphuric acid chars it without producing a sulphonic acid. By means of chloro-sulphonic acid a sulpho-derivative soluble in water is easily obtained. It yields soluble salts, which dye shades very similar to the primitive base. Naphthyl-nitro-rosaniline has a shade much more inclining to violet than the nitro-phenylic derivative.

Dissociation of Trichloro-sulpho-methyl Chloride.—E. Noeltig.—At a temperature of 200° this compound is resolved into sulphurous anhydride, carbon tetrachloride, carbon oxy-chloride, and thionyl-chloride.

Action of Sulphuric Acid upon Proto-catechuic Acid.—E. Noeltig and R. Bourcart.—The authors heated for eight hours to 140° to 145° in the 1 grm. proto-catechuic acid, 2 grms. benzoic acid and 50 grms. sulphuric acid at 1845 . The product was a small quantity of a light brown flocculent matter, which dyed mordanted cotton almost like alizarine, but is distinguished by the colour of its alkaline solution and by its absorption-spectrum. The same product was obtained on repeating the experiment without the benzoic acid. The reactions and general behaviour of the compound agree closely with those of rufopine, obtained in 1856 by Prof. Anderson when acting upon opianic acid with concentrated sulphuric acid.

Archives Néerlandaises des Sciences Exactes et Naturelles,
Tome xvii., Livraison 1me.

The Fundamental Formulæ of Electro-dynamics.—H. A. Lorentz.—A mathematical memoir, not capable of useful abridgment.

Tome xvii., Livraison 2me.

This issue contains no chemical matter.

Cosmos Les Mondes.
No. 6, June 10, 1882.

Boric Acid and the Preservation of Alimentary Substances.—Dr. Besana.—Boric acid is used medicinally, and is administered in doses of 20 to 50 centilitres (? centigrammes) at once. But this would be the quantity absorbed by any one who should drink a glass of milk or eat 20 grms. of butter prepared with this substance. This remark should suffice to render both medical men and the public suspicious.

No. 7, 1882.

A Cause of Offensive Odours too often Overlooked.—M. Vanderpol.—The author insists on the well-known fact that sulphates, and especially calcium sulphate, are liable to decomposition in presence of carbonaceous matter, air, and moisture, with liberation of carbonic acid.

Chemical Work produced by the Battery.—D. Tommasi.—Already noticed.

No. 8, 1882.

This number contains no chemical matter not already noticed.

No. 9, 1882.

A New Telephonic Post.—This paper requires the two accompanying illustrations.

Verhandlungen des Vereins zur Beförderung des Gewerbfleisses. April, 1882.

This number contains no chemical novelties.

Revue des Industries et des Sciences Chimiques et Agricoles,
No. 57, 1882.

Means of Lowering the Production-cost of Wheat.—H. Joulie.—The author ranks magnesia along with nitrogen, phosphoric acid, lime, and potash. The proportion of nitrogen and of phosphoric acid increases in wheat from the time of blossoming to maturity. Lime, on the contrary, decreases, and does not seem to play a very important part in the production of the grain, but along with potash serves chiefly in the development of the straw. Magnesia is more important than lime in the formation of grain. The mean requirements of wheat in order to produce 40 hectolitres per hectare are—Nitrogen, 92.6 kilos.; phosphoric acid, 37; lime, 25.2; magnesia, 12.2; and potash, 116.2. The "laying" of wheat and other corn is not due to a deficiency of silica in the stalks, but to a diseased condition, consequent on excessive moisture and deficient sunlight.

New Ferric Sulphates.—P. Marguerite-Delacharlonny.—The author enumerates 15 ferric sulphates. Six of them are soluble and contain respectively 2, 3, 4, 5, 6, and 7 molecules of ferric oxide to 12 mols. sulphuric anhydride. The remaining 9 sulphates are insoluble, and contain, along with the same quantity of sulphuric acid, from 9 to 84, or rather $84 + y$ mols. of ferric oxide. The author recognises 11 aluminium sub-sulphates—those with 2, 4, 6, 8, and 10 mols. aluminium sesquioxide to 12 mols. sulphuric anhydride being soluble, and the remaining insoluble with 12, 16, 18, 20, 24, and 30 mols. alumina to 12 mols. of acid. He finds that if alumina is added to a solution of ferric sulphate the ferric sulphate may be entirely displaced, yielding a solution of aluminium sulphate obtained perfectly free from ferric salts.

Purification of the Waste Waters of Manufactories.—Continued from the last number.

MISCELLANEOUS.

Royal Institution.—A new volume of the classified catalogue of the Library of the Royal Institution of Great Britain, by Mr. Vincent, the Librarian, is now ready: it includes the most important works published during the last twenty-five years, placed under their respective heads, accompanied by a Synopsis and Indexes of Authors and Subjects.

Distillation of Coal-Tar.—Professor Lunge has followed up his "Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali" by the preparation of a scarcely less important work—although of lesser bulk—on the Distillation of Coal-tar and Ammoniacal Liquor. It will be published, as his previous book was, by Mr. Van Voorst.

A New Isomer of Orcine.—M. E. Knecht has prepared a bioxy-toluene by setting out from metabinito toluene, which is transferred into nitrotoluidine by partial reduction. This nitrotoluidine successively transformed

into nitrocreosylol and amidocresylol gives ultimately an oxycreosylol or bioxytoluene.—*Moniteur Scientifique*.

Flameless Combustion.—At the soirée of the Society of Chemical Industry at Owens College, on July 6th, a new theory of combustion was practically illustrated by Mr. Thomas Fletcher, of Warrington, the results being so totally unexpected that many present would, and in fact did, go away with the impression that some deception was being practised. Mr. Jacob Reese, the inventor of the Reese fusing disc, has stated his belief that if it were possible to produce combustion without flame, the temperatures and duty obtained from any fuel would be enormously increased. It has remained for Mr. Fletcher to not only prove the possibility of flameless combustion in more than one form, but also to demonstrate practically the enormously high temperatures which can be obtained by this means. Taking a ball of iron wire about 3 lbs. in weight, Mr. Fletcher placed it on a slab of fire-clay, and directing a blowpipe flame on it for a few seconds, he suddenly blew the flame out. The temperature increased so rapidly that in a few seconds the wrought-iron fused and ran into drops, and this temperature was steadily maintained. The room was darkened, but the closest examination did not show a trace of flame, although the fact that the gas was burning was proved by repeatedly re-lighting and extinguishing it. The same experiment was repeated in another form by directing the flameless heat into a small fire-clay chamber, in which a refractory clay crucible, made specially for nickel melting, was partially fused and worked into a ball like soft putty, the sides of the fire-clay chamber being at the same time fused. The heat was so tremendous that the blowpipe laboratory which was given up to Mr. Fletcher for the evening was much too hot to be agreeable, in spite of open windows and ventilators. How far this discovery can be utilised remains to be seen; but it would appear that the presence of flame, usually considered to be a sign of combustion, is really an indication of imperfect results, and the best duty is to be obtained only when flame is totally absent. It is certain that such temperatures as obtained by Mr. Fletcher without flame have never previously been obtained with the fuel used, which was nothing more than a small gas supply for a quarter-inch pipe, assisted by an air blast.—As regards the soirée, the Society may be considered a promising infant. It is under a year old, and about seventeen hundred persons were present, the building being inconveniently crowded. The meeting next year is to be in London, the President for the year being Mr. F. A. Abel, C.B., F.R.S., of the Royal Arsenal, Woolwich.—*Warrington Guardian*, July 12, 1882.

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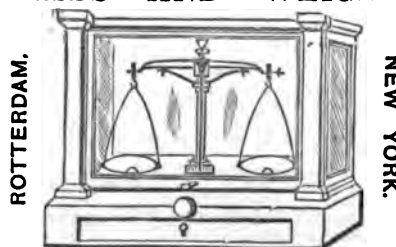
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GOLD MEDAL, INTERNATIONAL ELECTRICAL EXHIBITION, PARIS 1881.

THE CHEMICAL NEWS.

VOL. XLVI. No. 1183.

APPARATUS FOR THE ABSOLUTE DETERMINATION OF NITROGEN.*

By THOMAS S. GLADDING.

THE great value of the azotometer and mercury pump, devised by Profs. S. W. Johnson and E. H. Jenkins,† and their rapidly-extending use, will make any worthy improvement thereon welcome.

In the accompanying cut, improvement has been sought on four points.

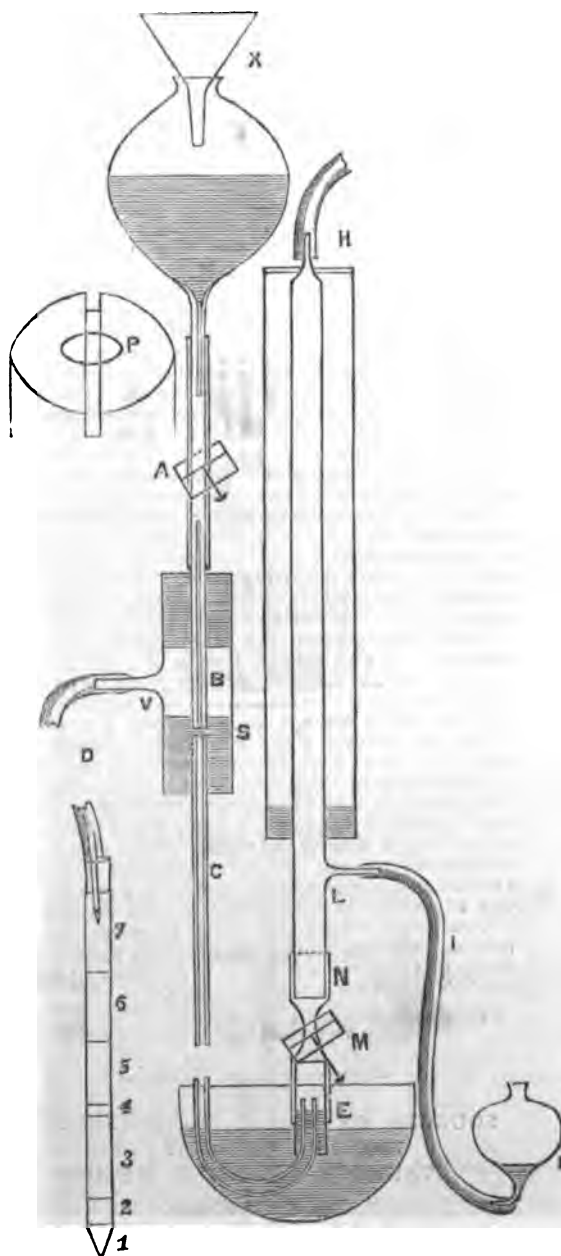
- 1st. In a more rapid exhaustion of the combustion-tube.
- 2nd. In a simpler and easier method of collecting the nitrogen gas.
- 3rd. In the attainment of a constant suction on the combustion-tube, thereby preventing blowing-out of the tube, so frequently a source of trouble to the analyst; and
- 4th. In the more thorough preliminary exhaustion of the combustion-tube and the consequent greater accuracy of the analysis.

A few words only will be needed to explain the accompanying section of the apparatus. Upon the side of the glass tube *s* is blown a stout piece of glass tubing *v*. The pure (so-called) rubber tubing *D*, with walls 4 m.m. thick to prevent collapse from atmospheric pressure, serves to connect the pump with the combustion-tube, and is securely bound to the tubes *v* and *o* (which are previously smeared with glycerin) by means of copper wire wound as tightly as possible. This tube *D* is clamped securely to the wooden frame of the apparatus just beyond the glass tube *v*, in order to remove the latter from all strain. The barometer tubing *c*, 7 m.m. in diameter, is forced up to within 5 m.m. of the top of the rubber cork *s*. The tube *B* is forced through the cork *s* into the cork *s* to within 1 m.m. of the tube *c*. The bore of *B* is about one-half that of *c* and is held exactly over the latter. The flow of mercury is regulated by the clamp *A*. The rubber tube *A* is bound tightly to *B*; its walls are 2 m.m. thick, and it is wrapped with one layer of kid or chamois skin to prevent wear by the action of the clamp *A*. The tube *c* is about 45 inches in length and curves up into the glass tube *E*. A stout glass finger-bowl is admirably adapted to serve as the vessel *E*. The tube *E* is connected with *N* by a large rubber tube tightly bound to both and closed at pleasure by the large screw clamp *M*. The cork *s* is shown in nearly top section at *P*. A slot about 3 m.m. wide and 5 m.m. deep is cut straight across the cork. In this way free access of the gas to be pumped off is given into the tube *c*, and at the same time the tube *B* is held exactly over the former.

The first point of improvement, viz., the more rapid exhaustion of the air in the combustion tube, is obtained by the peculiar construction of the pump. The tube *B* delivers exactly into *c*, and the bore of *c* being larger than that of *B*, there is no choking. The bore of *c* may be as large as 2 m.m. With such a size a complete vacuum in the combustion tube is easily obtained in from four to five minutes.

The second point of improvement is understood from the figure. The curving of the tube *c* up into *E* for the distance of 1½ inches removes all danger of loss of nitrogen and all necessity of handling or moving about any part of the apparatus.

The third point is obtained by the method of collecting the gas. When *M* is open and the reservoir *F* is placed a few inches below the level of the mercury in the vessel *E*, the pressure upon the mercury in the tube *E* is diminished, the mercury rises slightly in the tube *E*, and the internal pressure upon the walls of the combustion-tube is corre-



spondingly diminished. Provided no stoppage takes place in the tube itself from too close packing or the use of too fine a filling, no tube can blow out if this device is used. This suction may be increased at pleasure by lowering the vessel *F* still more, but a gentle aspiration is usually sufficient and safer.

* *The American Chemical Journal*, vol. iv., No. 7.

† *Ibid.*, ii., 27.

The fourth point, a more thorough exhaustion of the gas in the combustion-tube, is effected as follows:—About 0.6 grm. of bicarbonate of soda is placed in the tail of the tube at 1. The use of chlorate of potash has been found unnecessary in all ordinary work, from duplicate analyses performed with and without it. Its use introduces, moreover, a possible escape of oxygen gas beyond the metallic copper and a consequent error in the analysis. The space 2, about 2 inches in length, is filled with ignited asbestos. This is followed by the substance to be analysed at 3, mixed with copper oxide. This latter is about as fine as sea-sand, and is freed from dust or pulverised copper oxide by means of a fine sieve. It is strongly ignited and mixed with the substance while still warm. At space 4 is another 0.6 grm. of bicarbonate of soda. This is followed by a layer of copper shot at 5, and this again by a layer of coarsely granulated copper oxide. The analysis is begun by drawing the potash solution nearly to the top of the azotometer, then turning up lamps under 6 and at the same time starting the pump. When a perfect vacuum has been obtained and the copper oxide 6 is red hot, the lamp just beyond 1 is turned up, and a gentle heat just sufficient to drive off the CO_2 from it and not to heat space 3 is applied. When the tube is full of CO_2 this lamp is turned off and the tube again exhausted. By this process of washing out the tube, several tenths of a c.c. of additional gas are obtained, and almost the last traces of air are removed. The object in using finely-granulated copper oxide free from the powder is to give full play to this washing. On running the heat back the bicarbonate at 4 gives off CO_2 and re-fills the tube before the combustion of the substance at 3 begins. At this stage draw the potash solution again up to H.

To fill the azotometer with the potash solution, pinch the rubber tube I, and by the suction of the mouth applied at the rubber tube H, draw the mercury up as far as the tube L. Holding it there, close the clamp M, raise the reservoir F and fill it with the potash, which rises of course in the azotometer LH.

While the apparatus is in this condition, the tube remaining filled with mercury from M to L, the azotometer may be lifted and removed from the pump for any repairs without mixing the mercury and potash solution. In this position also it may be washed out for a fresh filling. Lower the reservoir F and invert it into a beaker. Upon opening the cock H all the potash runs out, and the tube HL may be rinsed clean with dilute acid introduced at H. The potash in tube LH may be drawn up to the glass cock H, either by closing the clamp M and then raising F to the level of H, or by the suction of the mouth applied at the rubber tube H. When the apparatus is not in use, F should be on a level with x to prevent any possible aspiration of air into the azotometer tube from the tube C.

Two simple rules may be given to prevent the potash solution in N from ever escaping into the vessel x: Close clamp M (x) whenever F is to be raised above x; (2) whenever the glass cock H is to be opened.

Laboratory of Stillwell and Gladding,
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SOURCES OF ERROR IN DETERMINING IRON IN ORES BY THE STANNOUS CHLORIDE METHOD.

By K. F. FOEHR.

THE volumetric process in question has met with general acceptance, because it yields concordant results in a very short time. Nevertheless, it is not free from considerable sources of error, which, however, chiefly compensate each other. The author shows that in the digestion of ferric ores a not insignificant portion of ferric chloride is volatilised. It may be easily shown that ferric chloride

evaporates, even at 50° ; if the digestion is performed in a small retort, more or less ferric chloride will be found in the receiver. This is still more the case at the boiling-heat required for titration. This error, however, is compensated by a proportion of pyrolusite, as it is generally found in hydroferrite (bog-iron ore, &c.), and also in the hæmatites. On decomposing such ores with hydrochloric acid there is formed free chlorine, which is partly absorbed by the solution of ferric chloride, and can be entirely expelled only by prolonged boiling, which would lead to an increased loss of ferric chloride.

In dissolving ferrous ores the case is the same, as they have to be first peroxidised by means of potassium chlorate or permanganate. Care must be taken that one of these sources of error does not too greatly exceed the other. The solution should be effected in flasks or beakers, and if the quantity of manganese peroxide present is in large quantity, it may be diminished by roasting.—*Berg. und Hütten Zeitung* and *Chemiker Zeitung*.

ACTION OF SULPHURETTED HYDROGEN UPON NICKEL CHLORIDE.

By M. H. BAUBIGNY.

CERTAIN metallic chlorides are more difficult to convert into sulphides than the corresponding sulphates if submitted under the same conditions to the action of hydrogen sulphide. The author has examined if a similar difference exists in the case of nickel. For this purpose he has taken equivalent weights of the chloride and the sulphate, operating always under comparable conditions, and from these experiments it results that nickel sulphate is converted into sulphide more rapidly than the chloride.

Thus, on making two solutions, each in 140 c.c. of water, 1 of 1.100 grm. of neutral sulphate, and the other of 0.925 grm. of neutral chloride, it was found, on leaving the two solutions for twenty hours at the temperature of the air (12° to 16°) in closed vessels after having saturated them with sulphuretted hydrogen at 0° , that the solution of sulphate contained 0.342 grm. of nickel salt, whilst that of the chloride at the expiration of the same time, contained a weight of nickel corresponding to 0.616 grm. of sulphate. In heat, in an acid liquid, an equally decided difference was found.

If, to the two foregoing solutions of sulphate and chloride, free acid is added, the same in weight as that present in the salt, we find, after having heated to 100° for four hours, only 0.077 sulphate in the solution of that salt, whilst that of the chloride retains a weight of nickel corresponding to 0.215 grm. of sulphate. In the two experiments the gaseous volume of the closed space was the sixth of the liquid volume.

For nickel it is therefore incontestable that the sulphate is more easily decomposed by sulphuretted hydrogen than the chloride, and consequently in comparable conditions hydrochloric acid opposes more energetically than a corresponding weight of sulphuric acid the transformation of nickel into sulphide, independently of any influence of a physical character. Still, as experience shows, the conclusions formed from observations made with nickel sulphate, are equally true for the chloride. With this latter salt, as with the sulphate, the transformation of the metal into sulphide takes place progressively, and is merely much slower. Thus, in a general manner, the action of hydrogen sulphide depends on the relative proportion of acid and metal, on the nature of the acid (sulphuric, hydrochloric, acetic, &c.), on the temperature, on the duration of the experiment, on the relative saturation of the liquid by sulphuretted hydrogen, that is to say, of the tension of this gas, and consequently, in heat, on the relative proportions of the gaseous and liquid volumes in a closed space.

The influencing causes being so many we have an explanation of the contradictory opinions put forward by different experimentators who have studied the separation of nickel from zinc, cadmium, copper, &c., by means of hydrogen sulphide.

For the separation of zinc and nickel in this manner in presence of acetic acid alone, there are required, at common temperatures, quantities of acid so much the greater as the proportion of nickel in solution is greater, and under the influence of a temperature but slightly elevated (40°), even in an open vessel, there is always a precipitation of sulphide. It is sufficient to raise to 70° in an open vessel an acetic solution of nickel acetate, which has been saturated with hydrogen sulphide, letting the liquid cool out of direct contact with the air, so as to avoid a too great loss of sulphuretted hydrogen and the occurrence of oxidation, in order to have all the nickel separated as sulphide, which is entirely deposited in ten to twelve hours.

The method is at fault only if the liquid contains oxidising agents, such as nitrates, but as under these conditions the nitric acid may be destroyed by boiling with ammonium hydrosulphate, it is sufficient to submit the solution to this treatment, repeatedly, if needful, in order to effect a complete precipitation of the nickel as sulphide in presence of free acetic acid.—*Comptes Rendus*.

REVISION OF THE ATOMIC WEIGHT OF ALUMINUM.

By J. W. MALLET, F.R.S.,

Professor of Chemistry in the University of Virginia.

(Concluded from p. 30.)

Calculation of Results.

In calculating the atomic weight of aluminum from the data furnished by the above described experiments, the atomic weights assumed for the other elements involved are those which result from the researches of Stas and the previous investigation by Dumas and Stas of the composition of water, namely—

O = 15.961 S = 31.996 N = 14.010

In regard to silver and bromine a difficulty arises from the fact that the relation between these elements was determined by Stas with metallic silver which, as Dumas* has pointed out, contained in all probability occluded oxygen. It appears from Dumas's experiments and from mine, that the quantity of oxygen that may be so retained varies with the conditions under which the metal is fused, and it is impossible now to ascertain precisely how much was present in that used by Stas, while the correction to be applied on this account, though small, is not inappreciable in its effect upon the atomic weight of the aluminum. Omitting to extract in the Sprengel vacuum the occluded oxygen from the silver used in my experiments would not have secured identical condition of the silver with that of the metal used by Stas, since the circumstances of fusion and cooling would probably not have been altogether the same, and it seemed best to use silver fully purified in this respect, so that my results might be directly comparable with any obtained in the future, since this source of error once pointed out ought not to be hereafter neglected. I have therefore used as the atomic weights of silver and bromine the numbers obtained by Stas (from his experiments on silver bromide and bromate), recalculated on the assumption that the metal employed by him would have yielded 57 c.c. (reduced to 0° C., and 760 m.m.) or 82 m.grm. of oxygen per kilogramme, this being the quantity obtained by Dumas from silver treated as near as possible as was in all likelihood that which Stas employed. This has the advantage of reducing the remaining error

to that only which depends on the difference between the real amount of oxygen which was present and that assumed in such calculation, instead of leaving the whole resulting from using Stas's numbers uncorrected, my silver having had the oxygen removed, while his had not been so treated. The atomic weights adopted then for these two elements are—

Ag = 107.649

Br = 79.754

Calculated Results.—The following are the values obtained for the atomic weight of aluminum from the different series of experiments, with the probable (mean) value resulting from each set, the difference from this mean of each individual experiment, and the probable error of the mean itself calculated in the usual way by the method of least squares:—

First Series.

Experiment.	A.	Diff. from mean.
I.	Al = 27.029	-0.011
II.	" 27.043	+0.003
III.	" 27.055	+0.015
IV.	" 27.068	+0.028
V.	" 27.005	-0.035
Mean ..	" 27.040	
Probable error of mean result	..	±0.0073

B.

VI.	Al = 27.114	+0.018
VII.	" 27.095	-0.001
VIII.	" 27.107	+0.011
IX.	" 27.067	-0.029
X.	" 27.096	0.000

Mean ..	" 27.096	
Probable error of mean result	..	±0.0054

Second Series.

A.

I.	Al = 27.035	+0.001
II.	" 27.021	-0.013
III.	" 27.046	+0.012

Mean ..	" 27.034	
Probable error of mean result	..	±0.0049

B.

IV.	Al = 27.028	+0.005
V.	" 26.993	-0.030
VI.	" 27.036	-0.013
VII.	" 27.028	+0.005
VIII.	" 27.030	+0.007

Mean ..	" 27.023	
Probable error of mean result	..	±0.0052

C.

IX.	Al = 26.999	-0.019
X.	" 27.034	+0.016
XI.	" 27.021	+0.003

Mean ..	" 27.018	
Probable error of mean result	..	±0.0069

Third Series.

A.

I.	Al = 27.012	+0.007
II.	" 27.005	0.000
III.	" 27.022	+0.017
IV.	" 26.988	-0.017
V.	" 27.006	+0.001
VI.	" 26.996	-0.009

Mean ..	" 27.005	
Probable error of mean result	..	±0.0033

* Loc. cit.

Experiment.	B.	Diff. from mean.
VII.	Al = 26.995	+0.005
VIII.	" 26.999	+0.009
IX.	" 26.977	-0.013
Mean ..	" 26.990	
Probable error of mean result ..		±0.0046

In view of the gradual loss of water which, as has been shown, crystallised ammonium alum undergoes on exposure to the atmosphere, I feel that of these various sets of experiments, B of the first series is entitled to least confidence, and the considerable difference between its results and the others leads me to favour its rejection. On the other hand, I am inclined to attach most weight to series three, A, since the method used was very simple in principle, the determination of one of the two quantities concerned was rendered very exact by the great volume of the hydrogen, the comparison was made directly with the standard element in our system of atomic weights and not through the intervention of any other substance whose atomic weight must be assumed, and the agreement of the results among themselves is particularly good, as shown by the probable error of the mean being the smallest reached.

General Mean of Results.—The general mean from all of the thirty experiments, if all be included in the calculation, is $Al = 27.032$, with a probable error for this mean of ± 0.0045 .

If series one, B, be excluded, the mean of all the remaining twenty-five experiments is $Al = 27.019$, with a probable error of ± 0.0030 . The third decimal having no positive value, we may take $Al = 27.02$. If integer numbers be used for O, N, C, Na, &c., $Al = 27$.

All the experiments which I have made are reported, except three or four in which there was manifest failure, as by accidental loss of material to a visible extent, and which were on that account not completed.

The general result adds, I trust, aluminum to the, unfortunately still limited, list of those elementary substances whose atomic weights have been determined within the limits of precision attainable with our present means of experiment.

Bearing of Final Result upon "Prout's Law."

It is interesting to observe that this result also adds one to the cases already on record of the numbers representing carefully determined atomic weights approaching closely to integers, and leads to a word on the reconsideration of "Prout's law." The recent researches of Mr. Lockyer, not unsupported by evidence drawn from other sources, have tended to suggest the possibility, at least, that the forms of matter which as known to us under ordinary conditions we call elements may be susceptible of progressive dissociation at enormously high temperatures, and, under circumstances in which this supposed state of dissociation admits of being spectroscopically observed, some of the characteristic features in the spectrum of what is usually known to us as hydrogen become in a very remarkable degree prominent. If such dissociation may really occur, and if the atoms of hydrogen as commonly known to us form either the last term, or any term not far removed in simplicity from the last, in the progressive breaking up of other forms of matter, it is obvious that "Prout's law," or some modification of it, such as was many years ago suggested by Dumas, *must* be true, the atomic weights of all the other so-called elements must be multiples of that of hydrogen, or multiples of that fraction of the hydrogen atom which may result from the dissociation of this body itself. If such fraction be very small as compared with the effect of the inevitable errors of experiment, the experimental verification or refutation of the law will prove impossible, but if it be considerable, as for instance one-half of the

commonly known hydrogen atom, or one-fourth, as assumed by Dumas, the question admits of practical examination.

Well deserved attention has for some years past been given to the labours of Stas in this direction, and his main result is no doubt properly accepted, if stated thus, that the differences between the individual determinations of each of sundry atomic weights which have been most carefully examined are distinctly less than their difference, or the difference of their mean, from the integer (or one-half or one-fourth unit which Prout's law would require.

But the inference which Stas himself seems disposed to draw, and which is very commonly taken as the proper conclusion from his results, namely, that Prout's law is disproved, or is not supported by the facts, appears much more open to dispute.

It must be remembered that the most careful work which has been done by Stas and others only proves by the close agreement of the results that *fortuitous* errors have been reduced within narrow limits. It does not prove that all sources of *constant* error have been avoided, and indeed this never can be absolutely proved, as we never can be sure that our knowledge of the substances we are dealing with is complete. Dumas's late observations on the occlusion of oxygen by metallic silver constitute an illustration of this, some of the best of Stas's results being thereby undeniably vitiated, though probably to but a minute extent.

Of course one distinct exception to the assumed law would disprove it, if that exception were itself fully proved, but this is not the case.

As suggested by Marignac and Dumas, any one who will impartially look at the facts can hardly escape the feeling that there must be some reason for the frequent recurrence of atomic weights differing by so little from accordance with the numbers required by the supposed law.

As the question stands at present, the following 18 atomic weights are the only ones which may be fairly considered as determined with the greatest attainable precision, or a very near approach thereto, and without dispute as to the methods employed—

*Oxygen ..	..	..	..	15.961
*Nitrogen ..	..	..	..	14.010
Chlorine ..	..	..	..	35.371†
Bromine ..	..	..	..	79.757†
Iodine ..	..	..	..	126.541†
*Sulphur ..	..	..	..	31.996†
*Potassium ..	..	..	..	39.042
*Sodium ..	..	..	..	22.987
*Lithium ..	..	..	..	7.005
Silver ..	..	..	..	107.667†
Thallium ..	..	..	..	203.655†
*Aluminum ..	..	..	..	27.019
*Carbon ..	..	..	..	11.97
*Phosphorus ..	..	..	..	30.96
Barium ..	..	..	..	136.84
Calcium ..	..	..	..	39.90
*Magnesium ..	..	..	..	23.94
Lead ..	..	..	..	206.40

† Stas's numbers, uncorrected for occlusion of oxygen by silver.

‡ Crookes's number modified by taking O = 15.961 instead of 15.96.

If now we discard altogether Dumas's assumption of multiples of 0.5 or 0.25, and consider simply the indications afforded of Prout's law in its original form, we may safely take the first decimal place of each of these numbers as quite freed from the influence of *fortuitous* errors, while the second decimal is nearly so in many instances. It appears that out of the 18 numbers, 10 (those to which an asterisk is prefixed) approximate to integers within a range of variation less than one-tenth of a unit. What then is the degree of probability that this is purely accidental, as those hold who carry to the extreme the conclusions of Berzelius and Stas? Since there are five intervals of 0.1 each between any integer and the 0.5 which

divides it from the next higher (or lower) integer, the result is given by the expression—

$$5^{-18} \left[1 + \frac{18}{17} \times 4 + \frac{18}{16} \times 4^2 + \frac{18}{15} \times 4^3 + \dots + \frac{18}{10} \times 4^8 \right]$$

and the probability in question is found to be only equal to 1 : 1097·8.

Of course this result might be easily varied by assuming other limits of precision as marking accordance with the law within the range of possible constant error, but this example seems to be based upon not unfairly assumed ground in this respect, and seems sufficiently to illustrate the point that not only is Prout's law not as yet absolutely overturned, but that a heavy and apparently increasing weight of probability in its favour, or in favour of some modification of it, exists and demands consideration.

THE DETECTION OF CHLORIDE OF LIME IN WATER.

By A. ANTHONY NESBIT, F.C.S.

THE increasing disputes between owners of paper mills and those preserving fish have rendered it advisable that chemists should have a very delicate test for bleaching-powder, which is the most deleterious pollution of streams by paper mills. I have consequently conducted a long series of experiments which have resulted in the following method, the delicacy of which is such that it enables us to detect from the 200th to the 400th part of that quantity of chloride of lime which is injurious to prussian carp (*Cyprinus Gibelio*).

The test used is a starch paste made in the following manner. 100 grs. of iodide of potassium are dissolved in 16 ozs. of boiling water and 100 grs. of starch mixed with 1 oz. of cold water are added gradually, and the whole boiled vigorously for 30 minutes (the long boiling being absolutely necessary for the production of the sensitiveness of the test).

This solution should be used as soon as possible after its preparation, as it rapidly decreases in delicacy, and the extraordinary fact must never be lost sight of that an excess of this test entirely destroys the reaction.

I test a water in the following manner, viz., two No. 5 beakers of the same shape are filled with the water under examination from the brook side and placed on a sheet of white paper, and 5 c.c. of the above solution are run from the burette into one of them; if no blue or violet colour occurs at once, the water is thrown away, the beaker is re-filled and 1 c.c. run in; if again no reaction, the beaker is again re-filled and half a c.c. added, the beaker re-emptied, and so on, till only the tenth of a c.c. is used in the beaker—it being found that the smaller the quantity of chloride of lime present the smaller the quantity of test required to exhibit it, and when we are dealing with small quantities of the chloride it has to be searched for with varying amounts of the test or it may escape notice. By judiciously applying the above method I can detect the $\frac{1}{100}$ th of a grain of commercial bleaching-powder in one gallon of water, or about $\frac{1}{100}$ th of a grain of "available chlorine" in a gallon.

Now from numerous experiments which I have conducted I find that it requires from one to two grains of commercial chloride of lime to inconvenience prussian carp, consequently we can readily detect in so-called polluted water the $\frac{1}{100}$ th to the $\frac{1}{200}$ th part of the quantity which is injurious to these fish; and hardy as the prussian carp are, I think it must be conceded that it would be

unreasonable to consider that the common trout is two hundred times as delicate.

In future disputes, therefore, between the owners of paper mills and fish preservers there will be no difficulty in deciding whether or no the manufacturer habitually discharges an injurious quantity of chloride of lime into the stream.

I find, however, that chloride of lime in small quantities is rapidly reduced by the action of the organic matter in the water, which fact must not be lost sight of, and every hour's delay in testing makes it more difficult to indicate pollution.

REMARKS ON DIDYMIUM.

By M. P. T. CLÈVE.

THE author has recently communicated to the Academy a preliminary note, the purpose of which was to render probable the existence of an unknown element between lanthanum and didymium, and accompanying the latter in a certain number of minerals. As a characteristic of this hypothetical element, provisionally designated Diβ, the author gave the spectral ray $\lambda = 4333\cdot5$, which is not found among the rays of lanthanum and didymium as laid down in 1874 by M. Thalén. Continued researches have subsequently convinced himself and M. Thalén that this ray belongs in fact to the spectrum of lanthanum, and that it is omitted in M. Thalén's tables by an error. The latter, in place of this ray, has indicated another adjacent and very strong ray, $\lambda = 4330$, which does not exist in the spectrum of lanthanum. There is here evidently a clerical error which has misled the author. An examination of the fractions intermediate between lanthanum and didymium has rendered the existence of an intermediate element scarcely probable. It seems to result from the researches of M. Brauner (see CHEMICAL NEWS, vol. lxvi., p. 16) that there is a variation in the atomic weight of didymium, which must be ascribed—as M. Brauner in fact does—to the presence of a foreign oxide. If this oxide is new, decipium has yet to be discovered. At present it appears very improbable that it is precipitated by ammonia after the true didymium.—*Comptes Rendus*.

Appearances of the Electric Arc in the Vapour of Carbon Disulphide.—MM. Jamin and Maneuvrier.—The authors have already described the modifications which the electric arc undergoes in the vacuum of pneumatic machines, when it is produced by a Gramme machine with alternating currents at high tension. The appearances are modified if gases or vapours are introduced into the vacuum, and are especially remarkable in the vapour of carbon disulphide. When the carbon points are separated there is a sort of explosion of light, incomparably superior to the ordinary lustre of the arc. On viewing it through darkened glasses we see a dazzling arc of the shape of a horse-shoe, with its extremities at the carbon points, and, besides, a long flame which escapes from the arc and rises vertically. The points of the carbons are red and very bright, but the arc is of a pale green, which predominates. The lustre increases so as to become intolerable as the tension of the vapour increases, but as the resistance of the medium augments at the same time, the arc is often extinguished, and it must be re-lighted by joining the two carbons. The spectrum is composed of four channelled parts in the red, the yellow, the green, and the violet, so identical that they might be taken for one and the same design transferred from the red to the violet. It is not probable that the light thus obtained will be of any practical value on account of its colour, except for lighthouses and signals sent to a distance.—*Comptes Rendus*, xcv., No. 1.

RESEARCHES ON THE
SUBSTITUTED BENZYL COMPOUNDS.THE SYNTHESIS OF ANTHRACENE AND PHENANTHRENE
FROM ORTHO-BROM-BENZYL-BROMIDE.*

By C. LORING JACKSON and J. FLEMING WHITE.

Discovery of Anthracene.

THE first notice of anthracene (under the name par-naphthaline) appears in a paper† on compounds of hydrogen and carbon, published by Dumas and Laurent in 1832. They obtained it in the fractional distillation of coal-tar from the portions with the highest boiling-point, but did not succeed in purifying it, as is shown by the melting-point 180°, and the formula $C_{15}H_6$. Laurent,‡ in 1835, studied its oxidation-product "para-naphthalese" (anthraquinone), and in 1837§ proposed the name anthracene for it; but neither of these papers, nor one|| also published by Laurent in 1839, gives a satisfactory account of the hydrocarbon, as the quantity at his disposal was too small for complete purification.

The first accurate characterisation of anthracene is due to Fritzsche,¶ who, in 1857, obtained from coal-tar a hydrocarbon with the formula $C_{14}H_{10}$, and melting-point 210°, forming a picric acid compound melting at 170°, but he did not identify it with the anthracene of Laurent. This was reserved for Anderson,** who, in 1861, repeated Laurent's experiments on a larger scale, and showed that his anthracene had the formula $C_{14}H_{10}$, melted at 213°, and was the same as Fritzsche's unnamed hydrocarbon.

In 1867, Fritzsche†† described the preparation of his reagent (dinitro-anthraquinone), and its use in the detection and purification of hydrocarbons; and Berthelot‡‡ reviewed all the previous work upon anthracene, determining its boiling-point 360° for the first time.

The next important paper on the subject appeared in 1869, when Fritzsche,§§ on account of its behaviour with his reagent, pronounced anthracene a mixture of two very similar hydrocarbons, which he called photene, melting-point 210° to 212°, and phosene, melting-point 193°.

In the following year (1870) general attention was attracted to anthracene by the appearance of Graebe and Liebermann's famous paper||| on anthracene and alizarine, in which they not only proved that alizarine was dioxanthraquinone by preparing it synthetically from anthracene, but described a large number of derivatives of anthracene, giving for the first time the melting-point of anthraquinone 273°. They showed, too, that Fritzsche's photene was identical with anthracene, but were unable to obtain his phosene, which Barbier¶¶ four years later showed was probably a mixture of anthracene and phenanthrene.

Syntheses of Anthracene.

In describing the syntheses of anthracene, all those made by the same method will be grouped together, and these groups will be taken up in the order of their discovery.

1. Limpricht*** was the first (in 1866) who made anthracene synthetically, unless, indeed one of the products obtained by Märcker,††† in 1865, from the action of heat on toluyl-sulphide must be considered anthracene-

sulphide, but there seems to be no sufficient ground for this supposition. Limpricht's method consisted in heating benzyl-chloride with water in a sealed tube to 190° for eight hours; the products were benzyl-ether, an oil $C_{14}H_{14}$, and anthracene.

Van Dorp,* in 1872, obtained the same result, and proved that the oil $C_{14}H_{14}$, which Limpricht had thought was dibenzyl, is benzyl-toluol. Finally Zincke,† in 1874, showed that this reaction resembled that of zinc-dust on a mixture of benzyl-chloride and benzol, and succeeded in isolating a chloride, $C_6H_5CH_2C_6H_4CH_2Cl$, and a complex hydrocarbon. He proved, further, that this synthesis was of little value in determining the constitution of anthracene, since neither anthracene nor benzyl-toluol was present in the product of the reaction, but they were formed during distillation by the breaking up of the more complex substances just mentioned.

2. In the year after Limpricht's synthesis was published, Berthelot, in developing his general method for the synthesis of complex hydrocarbons by passing simpler ones through a porcelain tube, heated to redness, obtained anthracene‡ from toluol (confirmed by Graebe§ in 1874), xylol, cumol, and mixtures of benzol with ethylene,¶ and of benzol with styrol; also traces of it by heating acetylene to redness in a glass tube over mercury. The same method was applied successfully by Van Dorp¶¶ to benzyl-toluol, that obtained from benzyl-chloride toluol and zinc-dust, as well as that from benzyl-chloride and water; by Kramers** to phenol (yellow heat); by Claus and Suckert†† to azobenzol; and by Barbier‡‡ to the mixture of toluol with benzol, and to that of diphenyl with ethylene, although the latter yielded only traces of anthracene. Barbier, in 1874, substituted for red-hot porcelain tubes vacuum sealed glass tubes heated to dull redness for a few minutes, and obtained in this way anthracene from benzyl-toluol, phenyl-xylol, diphenyl-methane, and liquid ditolyl. While Behr and Van Dorp§§ obtained the same result a year earlier by passing liquid benzyl-toluol, or liquid tolyl-phenyl-ketone, over gently-heated plumbic oxide. The synthesis from ortho-tolyl-phenyl-ketone by the aid of heat has been recently repeated by Ador and Rilliet.|||

3. The next synthesis of anthracene was published in 1872 by Kekulé and Franchimont,¶¶ who obtained a small quantity of anthraquinone from the by-products of the distillation of calcic benzoate. Their results were confirmed by Behr*** and Staedel.†††

4. Related to this method is that of Barth and Senhofer,‡‡‡ published in 1873, which consists in heating oxybenzoic acid alone, or with sulphuric acid.

5. In 1873, also, anthracene was first obtained by Zincke's reaction; for, although Zincke§§§ had not succeeded in finding it, Radziszewski and Zaleski||| got it from zinc-dust, benzyl-chloride and benzol, and Paterno and Filetti¶¶¶ by the action of zinc-dust on a mixture of benzyl-chloride and phenol; the latter, however, think that it is not formed directly, but by a secondary reaction from the benzyl-phenol, and this view is supported by a paper published in the following year by Zincke and Weber,**** who obtained it from a mixture of zinc-dust,

* Presented to the American Academy. Communicated by the Authors.

† Ann. Chim. Phys., 50, 187.

‡ Ibid., 60, 220.

§ Ibid., 66, 149.

|| Ibid., 72, 415.

¶ St. Petersburg Acad. Ber., 1857; Journ. Prakt. Chemie, 73, 286.

** Ann. Chem. Pharm., 122, 294.

†† Zeit. für Chemie, 1867, 289.

‡‡ Bull. Chim. Soc., 8, 231.

§§ Zeit. für Chemie, 1869, 387.

|| Ann. Chem. Pharm., Supp., 7, 257. A preliminary notice appeared in 1868, Ber. Deutsche Chem. Gesell., 49.

¶¶ Comptes Rendus, 79, 121.

*** Ann. Chem. Pharm., 139, 308.

††† Ibid., 136, 94.

* Ber. Deut. Chem. Ges., 1872, 1070; Ann. Chem. Pharm., 169, 207.

† Ber. Deut. Chem. Ges., 1874, 276.

‡ Bull. Chem. Soc., 7, 222.

§ Ber. Deut. Chem. Ges., 1874, 48.

|| Bull. Chem. Soc., 7, 279.

¶ Ber. Deut. Chem. Ges., 1872, 1070; Ann. Chem. Pharm., 169, 207.

** Ann. Chem. Pharm., 189, 131.

†† Ber. Deut. Chem. Ges., 1873, 37.

‡‡ Comptes Rendus, 79, 121, 600, 810; also Ann. Chim. Phys., series 5, 7, 515.

§§ Ber. Deut. Chem. Ges., 1873, 753.

|| Ibid., 1879, 2208.

¶¶ Ibid., 1872, 909.

*** Ibid., 1872, 971.

††† Ibid., 1873, 178.

||| Ann. Chem. Pharm., 170, 100.

§§§ Ber. Deut. Chem. Ges., 1873, 137.

||| Ibid., 1873, 810.

¶¶¶ Gazz. Chim., 1873, 121.

**** Ber. Deut. Chem. Ges., 1874, 1153.

benzyl-chloride and toluol, but suppose that all the anthracene is formed by the breaking up of complex hydrocarbons during the subsequent distillation, in the same way that it is formed from the product of the action of water on benzyl-chloride. More interesting, therefore, is the synthesis of Piccard,* who obtained anthraquinone by the action of zinc-dust on the chloride of phthalic acid and benzol at 220°.

Under this head should come also the recent experiments of Friedel and Crafts,† who, among their beautiful syntheses with aluminic chloride, made anthraquinone from the same mixture, and finally of Ador and Rilliet,‡ who, in 1879, obtained it from the chloride of ortho-toluic acid, benzol, and aluminic chloride.

6. Paterno and Filetti,§ in a paper published somewhat later, in 1873, describe the synthesis of anthracene by the distillation of benzyl-phenol with phosphoric pentoxide.

7. In the same year appeared a paper by Grimm,|| from Baeyer's laboratory, describing the synthesis of chinizarine from phthalic anhydride, hydroquinone, and sulphuric acid; while in 1874, Baeyer and Caro¶ found that phthalic anhydride yielded, with phenol, benzol-sulpho-acid, anisol, anisic acid, or salicylic acid, either oxy-anthraquinone or erythroxy-anthraquinone, both of which give alizarine by fusion with potassic hydrate; with pyro-catechin, guaiacol, or proto-catechuic acid, alizarine; with hydroquinone (see Grimm), quinic acid, thio-chronic acid, or the α - and β -sulpho-acids of hydroquinone, chinizarine. Still later, in 1875,** they added chlorphenol, boiling-point 218°, to the list of substances which form chinizarine, and converted chinizarine into purpurine by oxidation.

In his last paper†† on phthaleines and their derivatives, published in 1880, Baeyer shows their close relation to the anthracene group, ordinary phthalidine being dioxy-phenyl-anthranol, while a corresponding compound can be obtained from triphenyl-methane carbonic acid.

8. The syntheses of anthraquinone from benzoyl-benzoic acid also begin in 1873, when Plascuda and Zincke‡‡ obtained a little in oxidising crude benzoyl-toluol. In the following year Behr and Van Dorp§§ made it by oxidising tolyl-phenyl-ketone, and somewhat later in the same year converted β -benzoyl-benzoic acid into anthraquinone||| by heating it with phosphoric pentoxide, a process which ran smoothly and yielded 26 per cent of the theoretical amount, whereas the para-acid, under the same conditions, gave no anthraquinone whatever. The formation of traces of anthraquinone from the distillation of calcic benzoate alone, and of benzoic acid with phosphoric pentoxide, they ascribed to the previous formation of β -benzoyl-benzoic acid. Liebermann¶¶ next showed that fuming sulphuric acid produced essentially the same effect as phosphoric pentoxide, converting the β -benzoyl-benzoic acid into anthraquinone sulpho-acid, and suggested that this method might be of technical value in the future. Rotering and Zincke*** obtained a similar result by using phosphoric penta-chloride, while Thörner and Zincke††† worked out the process further, and showed that chlorine acting on ortho-tolyl-phenyl-ketone produced the same effect. Under this head might also be classed the action of hot plumbic oxide on tolyl-phenyl-ketone already described in Group 2.

9. Closely related to the preceding group is the synthesis depending on the action of zinc-dust on tolyl-phenyl-ketone, which was studied by Behr and Van Dorp

in 1873;* and also in 1874,† when they proved that the para-compound gives no anthracene, and more recently by Ador and Rilliet.‡

Finally, the occurrence of (10) anthracene among the products of the action of potassic nitrite on benzyl-chloride,§ and of (11) anthraquinone from the oxidation of isotropic acid,|| should be mentioned.

(To be continued.)

CORRESPONDENCE.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

SIR,—Referring to the letter printed under this heading (CHEM. NEWS, vol. xlv., p. 22), I think your correspondent is certainly in error in stating that such sugar chemists as Tucker would fail to detect the presence of starch sugar when mixed with the product of the beet or cane. On p. 136¶ Tucker expressly states that the percentage of cane sugar may be read directly on the saccharimeter "when no other optically active body is present." This, I take it, covers the whole ground of contention in reference to starch sugar, which is, as everybody knows, optically active, and samples containing it require therefore to be further tested by processes given in detail in Tucker's book. Such being the case it is hardly fair to pick out an isolated sentence, and on this solitary statement proceed to draw the inference that "such sugar chemists as Tucker" would pass over the presence of starch sugar in a mixture of that substance with cane sugar. Now, as a matter of fact, some solid starch sugars will, when mixed with refiners' pieces, so increase the specific rotation of the sample as to give readings above 100 per cent—this being due to the high specific rotatory power of dextrine [α]_D + 193, and maltose [α]_D + 139.2 as against [α]_D 66.5, that of cane sugar.

Your correspondent I consider takes an unfair advantage when he quotes in one paragraph of his letter Professor Wiley's analyses as proving the serious error introduced by heating starch sugar with hydrochloric acid. These experiments were made on liquid glucose and solid grape sugar prepared for confectioners' use, both these substances containing considerable quantities of dextrine and maltose, which very naturally undergo further conversion into dextrose in the presence of large excess of acid, when heated, with consequent reduction of rotatory power; in calling attention in an ensuing paragraph to what he calls "another error" in Tucker's book he states that mixed cane and starch sugars do not polarise higher but lower than pure cane sugar on account of the lower specific rotatory power of "highly converted starch sugar" or dextrose. Now surely this is hardly fair.

If cane sugars are mixed with liquid glucose or confectioners' grape sugar, such as was experimented on by Professor Wiley, the direct polarisation would undoubtedly in many cases cause the analysis to add up to more than 100, but, says your correspondent, only highly converted starch sugar is used, which is really almost pure dextrose, and therefore the direct polarisation is lower than the true one, so that in one paragraph your correspondent states on authority that commercial starch sugars (liquid glucose and confectioners' grape sugar) do alter by heating with hydrochloric acid, in the ordinary inversion process, and in the next paragraph he asserts that the polarisation of a mixed sugar is lower than the correct reading (which is impossible where such sugars used for mixing

* Ber. Deut. Chem. Ges., 1874, 1785.

† Comptes Rendus, 84, 1450.

‡ Ber. Deut. Chem. Ges., 1879, 2298.

§ Gazz. Chim., 1873, 231.

¶ Ber. Deut. Chem. Ges., 1873, 506.

|| Ibid., 1874, 568.

** Ibid., 1875, 152.

†† Ann. Chem. Pharm., 202, 36.

‡‡ Ber. Deut. Chem., 1873, 906.

§§ Ibid., 1874, 16.

|| Ibid., 1874, 576.

¶¶ Ibid., 805.

*** Ibid., 1876, 631.

††† Ibid., 1877, 1477.

* Ber. Deut. Chem. Ges., 1873, 753.

† Ibid., 1874, 16.

‡ Ibid., 1879, 2298.

§ Brunner, Ibid., 1876, 1744.

¶ Fittig, Ibid., 1879, 1739.

¶¶ "Manual of Sugar Analysis."

as those experimented on by Wiley), on account of the starch sugar being in such a highly converted state that it consists of dextrose, the rotation of which substance would not be altered by the inversion process of Clerget.

As a rule the manufacturer of this mixed sugar is sufficiently educated by the American chemist to select for his purpose almost pure dextrose, which can be manufactured in the state of a white powder, and this he mixes with crushed loaf or other powdered white sugar. The detection of this sophistication is perfectly easy to those who are acquainted with the appearance and properties of commercial sugars. In the case of the class of sugars known as "Dutch crushed," the mere fact of the direct reading on the saccharimeter falling as low as the highest figure, 93.7, quoted by your correspondent, is sufficient to indicate that the sample is of American origin, and therefore suspicious, while a figure so low as 78.5 is only approached by the lowest Manilas and Jaggerys sugars, so impure as to be utterly unfitted for direct consumption. So that sugars (which from their general appearance and whiteness would be classed as commercially pure articles) giving such low polariscopic readings would at once cause them to be made the subject of special enquiry and exhaustive analysis.

Had your correspondent carefully read Tucker's book it would have assisted in dispelling some of the mist which is evidently enveloping his brain, and he would have a clearer idea of the various differences between starch sugars: more especially he would have understood that liquid glucose and confectioners' grape sugar are not "highly converted" articles, and that the "highly converted" article consists of pure dextrose, which is worth little more than half the price of cane sugar, and which science in America has assisted her manufacturers and refiners in so successfully introducing into cane sugar under such extremely favourable monetary conditions.—I am, &c.,

R. H. HARLAND.

37, Lombard St., London,
July 18th, 1882.

DETERMINATION OF ARSENIC IN COPPER.

To the Editor of the Chemical News.

SIR,—My attention has been called to an article in the issue of your journal (CHEM. NEWS, vol. xlv., p. 255), which had hitherto escaped my notice. It is on the determination of arsenic in copper, and in it the author, Mr. A. Humboldt Sexton, claims in respect of one method which I may call the iron method that he devised it. That particular process was communicated to me by the late Mr. W. J. Ward, with whom I sometimes exchanged notes on metallurgical analysis, and whose experience in these matters was very extensive. I introduced the process into my laboratory, and there Mr. Sexton got his knowledge of it in his capacity of my laboratory assistant. In the same capacity he made at my direction certain experiments on the *modus operandi* to which he appears to refer in his paper.

I don't think it is necessary to say more on this subject, and leaving the matter to the judgment of yourself and your readers,—I am, &c.,

DAVID WATSON.

The Broughton Copper Company, Limited,
Manchester, July 24, 1882.

SALT IN BEER.

To the Editor of the Chemical News.

SIR,—In a recent case a certificate of one of the public analysts was upset by the superior certificate of the Somerset House authorities, who had taken into consideration the amount of sodium salts being low. As this is (to my knowledge) the first instance of the soda salts being

examined, will you allow me to point out how such reasoning, albeit that it was more correct, can in some instances be rendered untrustworthy. I do not intend to criticise the facts of the case alluded to, as the commissioners' decision seems to have been perfectly reasonable and just.

1. Many waters, notably those of the chalk beneath the London clay, contain sodium as carbonate and sulphate, much exceeding that as chlorides. Here a guilty party can escape by reason of the doubtfulness.

2. The ratio between potash and soda cannot be introduced, since low class sugars, maize, &c., are so variable in use.

3. The disturbing effects of the addition to beer of chloride of magnesium, which would be liable to be found on analysis as chloride of potassium.

4. The disturbing effects of a preservative agent composed of chloride of potassium and sodium, according to Patent 1880—1471.

5. The variation of the ash of malt consequent on longer or shorter "steeping" of the barley in water.

6. The absence of a series of standard analyses of the alkalis in beer ash.

On these grounds I believe that if we desert the old system of examination of materials for chlorine with allowance thereof, and substitute instead allowance for soda *without further enquiry*, we are entering upon a course which, though in many cases useful, is certain to defeat its own object by casting unnecessary doubts on every analysis.—I am, &c.,

OBSERVANS.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 1, July 3, 1882.

Electrolysis of Oxygenated Water.—M. Berthelot.—The author explains on thermo-chemical principles the two distinct modes of the electrolytic decomposition of oxygenated water, with and without the disengagement of hydrogen. These two modes may co-exist, as the author has shown in his study of the electrolysis of iron and manganese sulphates. The co-existence is shown by the variation of the volume-proportions of hydrogen and oxygen liberated.

Electromotor Force of a Zinc-carbon Element.—M. Berthelot.—In this paper, which is a critique on those of M. Tommasi on the same subject, the author maintains that the zinc-carbon battery, from the fluctuating nature of its effects, is unfit for any operation which requires a constant electromotor force. The chemical effects vary in a correlative manner. If two zinc-carbon elements decompose potassium sulphate whilst two zinc-platinum elements do not, it is because the chemical reactions in the two cases are not the same.

Decomposition of Gallium Protochloride by Water.—M. Lecoq de Boisbaudran.—In a former communication the author has described the disengagement of gases which accompanies the solution of anhydrous gallium protochloride in water, pure or acidulated (*Comptes Rendus*, August, 1881, p. 295). This disengagement, scanty when the liquid remains concentrated, becomes tumultuous if it is largely diluted. A result quite analogous is produced when metallic gallium is dissolved in the cold in a small quantity of concentrated hydrochloric acid. There escapes a regular current during the whole continuance of the action, and there remains a clear liquid, which if left to itself gives off gas very slowly, but which liberates torrents as soon as it is diluted with

water. Each new dilution occasions a fresh escape of gas, the intensity of which decreases progressively until a limit is reached at about 10 c.c. for 0.1 gm. of the gallium employed. If the metal were less rare this reaction might be the subject of a curious lecture experiment.

Theory of the Equipotential Figures obtained by the Electro-chemical Method.—Ad. Guébbard.—The rings of Nobili owe their origin not to a permanent electric condition, but to a very brief variable state, and to a kind of reaction of the slender layer of metal, which after having at first afforded the most easy track for the current, tends almost immediately after to repel it.

Determination of Vapour-Densities in Glass Globes at the Temperature of the Boiling-point of Selenium.—M. L. Troost.—The author having first described his experimental arrangements, shows that the vapour of iodine has at or about 665° a coefficient of expansion differing very slightly from that of the air, whilst its coefficient of compressibility is even at 440° strikingly different from that of the air. The vapour of sulphur, on the contrary, has a density at 440°, independent of pressure. It preserves at this temperature, however feeble the pressure, the value 6.6, threefold of the value 2.2, which it has at elevated temperatures. It behaves like ozonised oxygen, the density of which, equal to one and a half times that of ordinary oxygen, is at 10° independent of pressure. As ozone is gradually decomposed as the temperature rises, returning to the state of ordinary oxygen, it was interesting to determine that the vapour of sulphur passes, like oxygen, progressively from one allotropic state to another as the temperature rises, and that consequently its vapour-density taken at an intermediate temperature between the boiling-point of sulphur and that of cadmium, has a value intermediate between 6.6 and 2.2.

Remarks on Didymium.—M. P. T. Clève.—(See page 43.)

Action of Sulphuretted Hydrogen after Nickel Chloride.—M. H. Baubigny.—(See page 41.)

The Isomerism of Cuprous Sulphites.—M. Etard.—There are two isomeric cuprous sulphites, the one white, of sp. gr. 3.83 at 15°; the other red, of sp. gr. 4.46 at the same temperature. The former, which the author has identified for the first time, is the normal salt, corresponding to the colourless cuprous chloride and acetate. The second is a polymer, and the author names it cuprous isosulphite.

Reduction of certain Ores of Silver in the Moist Way by Hydrogen.—M. P. Laur.—Whenever hydrogen takes its rise in a liquid containing silver sulphide, chloride, bromide, and iodide, the silver compound is destroyed, and the silver is deposited in the metallic state. The following reaction may be utilised in metallurgy:—The silver ore is ground to a fine powder, and put in a cast-iron vessel, into which is poured a weak alkaline lye, 1 part soda to 100 parts water. There is also prepared an amalgam of 3 parts tin to 100 parts mercury, which is added to the ore, and the whole is raised to a boil. The hydrogen decomposes the argentiferous compounds. The silver amalgamates with the mercury, the sulphur passes into the liquid as an alkaline sulpho-stannate, whilst the chlorine, iodine, and bromine give corresponding sodium salts. There is no appreciable loss of mercury. This reaction might be usefully substituted for the Mexican "Cazo" and the Californian "Pan" processes. The waste of mercury is suppressed, and the extraction of the silver is more complete.

Action of Chloroform upon β -Naphthol.—M. G. Rousseau.—This reaction gives rise to various products, which may be classed in two very distinct groups:—1st. Bodies insoluble in alkalies, namely, glycol, glycolic ether, a monatomic alcohol, and a resin containing 96 per cent of carbon. 2nd. Bodies soluble in alkalies, i.e., aldehyde and a highly oxygenised resin.

The Introduction into the Arts of Vanadium Extracted from the Basic Slags of Creusot.—MM. G. Witz and Osmond.—M. Dieulaufait has recently shown the general diffusion of vanadium and titanium in primitive formations. Hence the presence of vanadium in argillaceous iron ores. Vanadium, being chemically analogous to phosphorus, accompanies the latter in all stages of the iron manufacture. Both are found concentrated in different slags, and especially in those of the Bessemer process as modified by Thomas and Gilchrist. The steel works of Creusot, supplied from the oolite of Mazenay, produce slags exceptionally rich in vanadium, containing 1.92 per cent of vanadic acid = 1.08 metallic vanadium. From these works alone 60,000 kilos. of vanadium are obtainable yearly. The authors have succeeded in extracting the vanadium either as ammonium meta vanadate, or in the form of new vanadic products more specially adapted for the production of aniline blacks.

Moniteur Scientifique, Quenouville.
June, 1882.

Patents on Colouring Matters taken in Berlin.—Titles and specifications of twenty-one patents for the manufacture of dyes and colours.

Contribution to the Study of Tetra-hydro-cinchonic Acid.—H. Weidel.—The author has studied the behaviour of tetra-hydro-cinchonic acid with acetyl chloride, with methyl iodide, nitrous acid, sulphuric acid, and zinc powder.

Contribution to the History of Piperidine.—M. C. Schotten.—Translated from the Berlin *Berichte*.

On Tropine.—M. G. Merling.

Petroleum and Picene.—M. J. Walter.—The author discusses the conflicting theories on the origin of petroleum. Berthelot maintains that the interior of the globe contains free alkaline metals which, in presence of carbonic acid, yield metallic acetylides, which on being decomposed by watery vapour furnish acetylene. But it has been already proved that acetylene may be polymerised, so as to produce aromatic carbides or the derivatives of marsh-gas by the absorption of hydrogen. All these reactions have been demonstrated experimentally, but the presence of alkaline metals in the interior of the globe is an unproved and improbable hypothesis. According to Byasson, the hydrocarbons of petroleum are formed by the action of water, carbonic acid, and sulphuretted hydrogen upon incandescent iron. Mendeleeff likewise admits that the action of watery vapour upon iron carbides may give rise to the formation of petroleum. To these hypotheses is opposed the absence of iron in volcanic products. Other investigators consider that petroleum is formed not synthetically, but by the decomposition of organic matter. This view is defended by the author, who regards petroleum as a product of the dry distillation of lignites.

On Carbostryle.—MM. Friedlaender and Ostermeier.—A translation from the Berlin *Berichte*.

A New Method of Preparing Nitro-alizarine.—M. S. E. Simon.—If dinitro-oxyanthraquinone at 20 per cent suspended in water is mixed with a very little caustic soda there is formed immediately a deep red solution of the sodium salt. On prolonged ebullition the colour passes successively to a brown-red and to purple, and the liquid is evaporated until the sodium salt is precipitated in flocks. This salt on decomposition by hydrochloric acid furnishes a yellow body, which on crystallisation from acetic acid forms brilliant needles of an orange-yellow.

Condensed Milk.—From the *Journal of Applied Science*.

Presence of Fat in the Deposits of Steam-Boilers.—T. T. P. Bruce Warren.—From the *Journal of the Society of Arts*.

Processes for Tanning.—From Iron.

Fire-proof Paper and Impressions.—From the *Scientific American*.

The Saccharines.—Leon Cuisinier.—The author proposes to name the saccharine of M. Peligot *glucosaccharine*, in contradistinction to its isomer obtained from maltose, which he names *malto-saccharine* or *iso-saccharine*.

Analysis of Beer.—H. Bungener.—This memoir treats merely of general preliminaries, the actual methods being promised for a future communication.

Phosphatic Manures.—M. T. Walter.—From the *CHEMICAL NEWS*.

Volumetric Determination of Lead.—M. Buisson.—The author's method is based on the precipitation of lead by potassium bichromate in excess; the excess of the bichromate employed is found by decomposing it in the cold by potassium iodide in presence of sulphuric acid. The reaction is almost instantaneous at common temperatures, and is complete in two or three minutes. The iodine set at liberty is determined with sodium hyposulphite as indicator: either the disappearance of the blue tint of the iodide of starch or the decolouration of iodine in carbon disulphide may be made use of. The author prefers the latter, as being much the more sensitive, for the liquid being always tinged greenish by the salt of chrome produced, the sensibility of the reaction of starch is much lessened. The standard solution of bichromate is prepared by dissolving in distilled water 14.248 grms. pure fused potassium bichromate, and making the solution up to 1 litre: 5 c.c. precipitate exactly 0.1 grm. lead. The relation between the standard liquids of bichromate and hyposulphite is thus determined. With a pipette, 25 c.c. of the bichromate liquid are taken and diluted with water to 250 c.c. Of this new solution 50 c.c. are taken and put into a stoppered bottle capable of holding 250 to 300 c.c. The liquid is then acidulated with sulphuric acid (free from chlorine and nitrous vapours), and about 0.5 grm. potassium iodide is added. When the decomposition is effected about 5 c.c. carbon disulphide or chloroform is added. The solution of hyposulphite is then added by means of a burette graduated in one-tenths of a c.c., until the rose colour of the carbon disulphide disappears: the quantity of hyposulphite added corresponds to 5 c.c. of bichromate or 0.1 grm. of lead. The solution of hyposulphite is sufficiently strong if from 35 to 40 c.c. are required to decolourise the iodine set at liberty by 5 c.c. of bichromate. The sulphuric acid should not be added in too large excess, as it might decompose the hyposulphite before the latter can act upon the iodine. In order to verify the standard of the bichromate, 0.3 grm. of pure lead is dissolved in pure, hot nitric acid, for which purpose there are required about 20 drops of acid in 5 c.c. of water. When the lead is dissolved the liquid is heated to a boil to expel nitrous vapours, and the excess of acid is saturated with potassa until a permanent precipitate is obtained, which is then re-dissolved by a few drops of acetic acid. The solution of lead is poured into a graduated flask of 250 c.c. with 25 c.c. of the bichromate solution, and distilled water enough to make up the 250 c.c. After standing for fifteen minutes, the liquid is poured upon a dry filter, and the operation is completed in the same manner as if the bichromate alone were present, as described above. The difference between the quantities of hyposulphite employed for decomposing the bichromate before and after partial precipitation by lead represents the bichromate in c.c. of hyposulphite, and consequently the lead which has been precipitated. For the assay of lead ores, the sample is ground in an agate mortar, and from 0.5 to 1 grm., or more, is weighed out according to its richness. The weighed portion is dissolved in a few c.c. of boiling hydrochloric acid, and a little potassium chlorate is then added to peroxidise the iron, and the whole is boiled for a few minutes to expel chlorine. The liquid is then saturated with an excess of

caustic potassa, and the precipitate is re-dissolved in a few drops of acetic acid. It is then boiled again to precipitate the iron, and aid the solution of the lead sulphate if any has been produced. The solution is filtered, and the precipitate is washed in boiling water. To the cold liquid there are added 25 c.c. of bichromate and water, so as to make up 250 c.c. After settling for fifteen minutes, the liquid is poured upon a dry filter. 50 c.c. of the filtrate are taken and treated as described above.

Cinchotone, Hydro-cinchonidine, and Hydro-quinidine.—MM. Jobst and Bœhringer.

MISCELLANEOUS.

Institute of Chemistry.—As will be seen from the advertisement on the cover of our present issue, it is proposed to have a social gathering of the Fellows and Associates of the Institute at Birmingham, when it is hoped that arrangements will be made to enable the members to visit some of the more important chemical works in the neighbourhood. The meeting will in all probability take place on a Friday, as the most convenient day in the week for those who live in London or at a distance from Birmingham, and will give an opportunity to those who desire to do so to spend another day or so in the neighbourhood. We understand that the matter is in the hands of an energetic committee, and that the list of stewards already includes the names of many well-known chemists.

South London School of Chemistry.—The following prizes have been awarded to the successful competitors at the school examinations held on the 4th, 5th, 7th, and 8th of July:—*Medals*: Senior Chemistry, Mr. Caldecot; Junior Chemistry, Mr. T. B. Tyson; Botany, Miss Mitten; Materia Medica, Mr. F. Ransome; Practical Dispensing and Pharmacy, Mr. C. L. Dillon. *Certificates*: Senior Chemistry, Mr. Bain; Junior Chemistry, Mr. F. Ransome; Botany, Mr. C. E. Harston; Materia Medica, Mr. C. E. Harston; Practical Dispensing and Pharmacy, Mr. T. B. Tyson. Certificates of Merit were also awarded to Messrs. Dowdeswell, Dillon, Hornby, Schofield, Thomas, and Thistleton.

The Status of the Scientific Chemist.—We copy the following advertisement from the *Chemiker Zeitung*, which has obtained it from the *Deutsche Zucker Industrie* (1882, p. 615):—"An academically educated chemist, fully acquainted with the manufacture (sugar), who can undertake in summer the *copper-smiths' work*, or the oversight of the *teams of draught-oxen*, is wanted for immediate engagement." Any comment would here be an anticlimax.

The Diploma Trade.—The *New York Medical Gazette* publishes the following curiosity, which we copy *verbatim et liberatim*:—"College of Physicians and Surgeons, Joplin, Mo., 5, 28, 1882. Gents.—Please send *price list of Doctors* and *Druggist*. Names by states as I want to mail *several thousand Annual catalogues* to the *profession* all over the U.S.A. and Canada. I am starting an embryonic pioneer Medical College, and I must, of necessity, noise it around to the world to make it pay me. An early reply will greatly oblige, your respectfully, &c.—J. C. PETIT, M.D., Dean."

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Carbonising.—Can any of your readers give me information as to the Berthollet system of carbonising, or give the name of any work referring to the same.—F. L. HARRIS.

THE CHEMICAL NEWS.

VOL. XLVI. No. 1184.

ELECTRIC LIGHTING BY INCANDESCENCE.*

By JOSEPH W. SWAN.

SPEAKING in this place on electric light, I can neither forget, nor forbear to mention, as inseparably associated with the subject and with the Royal Institution, the familiar, illustrious names of Davy and Faraday. It was in connection with this Institution that, eighty years ago, the first electric light experiments were made by Davy, and it was also in connection with this Institution that, forty years later, the foundations of the methods, by means of which electric lighting has been made useful, were strongly laid by Faraday.

I do not propose to describe at any length the method of Davy. I must, however, describe it slightly, if only to make clear the difference between it and the newer method which I wish more particularly to bring under your notice.

The method of Davy consists, as almost all of you know, in producing electrically a stream of white-hot gas between two pieces of carbon.

When electric light is produced in this manner, the conditions which surround the process are such as render it impossible to obtain a small light with proportionally small expenditure of power. In order to sustain the arc in a state approaching stability, a high electro-motive force and a strong current are necessary; in fact, such electro-motive force and such current as correspond to the production of a luminous centre of at least several hundred candle-power. When an attempt is made to produce a smaller centre of light by the employment of a proportionally small amount of electrical energy, the mechanical difficulties of obtaining a stable arc, and the diminution in the amount of light (far beyond the diminished power employed), puts a stop to reduction at a point at which much too large a light is produced for common purposes.

The often-repeated question, "Will electricity supersede gas?" could be promptly answered if we were confined to this method of producing electric light; and for the simple reason that it is impossible, by this method, to produce individual lights of moderate power.

The electric arc does very well for street lighting, as you all know from what is to be seen in the City. It also does very well for the illumination of such large enclosed spaces as railway stations; but it is totally unsuited for domestic lighting, and for nine-tenths of the other purposes for which artificial light is required. If electricity is to compete successfully with gas in the general field of artificial lighting, it is necessary to find some other means of obtaining light through its agency than that with which we have hitherto been familiar. Our hope centres in the method—I will not say the *new* method—but the method which until within the last few years has not been applied with entire success, but which, within a recent period, has been rendered perfectly practicable—I mean the method of producing light by *electrical incandescence*.

The fate of electricity as an agent for the production of artificial light in substitution for gas, depends greatly on the success or non-success of this method; for it is the only one yet discovered which adapts itself with anything like completeness to all the purposes for which artificial lighting is required.

If we are able to produce light *economically* through the medium of *electrical incandescence*, in small quantities, or in large quantities, as it may be required, and at a cost

not exceeding the cost of the same amount of gas light, then there can be little doubt—there can, I think, be *no* doubt—that in such a form, electric light has a great future before it. I propose, therefore, to explain the principle of this method of *lighting by incandescence*, to show *how it can be applied*, and to discuss the question of *its cost*.

When an electrical current traverses a conducting wire, a certain amount of *resistance* is opposed to the passage of the current. One of the effects of this conflict of forces is the development of heat. The amount of heat so developed depends on the nature of the wire—on its length and thickness, and on the strength of the current which it carries. If the wire be thin and the current strong, the heat developed in it may be so great as to raise it to a white heat.

The experiment I have just shown illustrates the principle of Electric Lighting by Incandescence, which is briefly this—that a *state of white heat may be produced in a continuous solid conductor by passing a sufficiently strong electrical current through it*.

A principle, the importance of which cannot well be over-estimated, underlies this method of producing light electrically—namely, the principle of *divisibility*. By means of electric incandescence it is possible to produce exceedingly small centres of light, even so small as the light of a single candle; and with no greater expenditure of power, in proportion to the light produced, than is involved in the maintenance of light-centres 10 or 100 times greater. Given a certain kind of wire, for example a platinum wire, the root of an inch in diameter, a certain quantity of current would make this wire white-hot whatever its length. If in one case the wire were one inch long and in another case ten inches long, the same current passing through these two pieces of similar wire would heat both to precisely the same temperature. But in order to force the same current through the ten times longer piece, ten times the electro-motive force or, if I may be allowed the expression, electrical pressure, is required, and exactly ten times the amount of energy would be expended in producing this increased electro-motive force.

Considering, therefore, the proportion between power applied and light produced, there is neither gain nor loss in heating these different lengths of wire. In the case of the longer wire, as it had ten times the extent of surface, ten times more light was radiated from it than from the shorter wire, and that is exactly equivalent to the proportional amount of power absorbed. It is therefore evident that *whether a short piece of wire or a long piece is electrically heated, the amount of light produced is exactly proportional to the power expended in producing it*.

This is extremely important; for not only does it make it possible to produce a small light where a small light is required, without having to pay for it at a higher rate than for a larger light, but it gives also the great advantage of obtaining *equal distribution* of light. As the illuminating effect of light is inversely as the square of the distance of its source, it follows that where a large space is to be lighted, if the lighting is accomplished by means of centres of light of great power, a much larger total quantity of light has to be employed, in order to make the spaces remotest from these centres sufficiently light, than would be required if the illumination of the space were obtained by numerous smaller lights equally distributed.

In order to practically apply the principle of producing light by the incandescence of an electrically heated continuous solid conductor, it is necessary to select for the light-giving body a material which offers a considerable *resistance* to the passage of the electric current, and which is also capable of bearing an exceedingly high temperature without undergoing fusion or other change.

As an illustration of the difference that exists among different substances in respect of *resistance* to the flow of an electric current, and consequent tendency to become heated in the act of electrical transmission, here is a wire formed in alternate sections of platinum and silver; the wire is perfectly uniform in diameter, and when I pass an

* A Lecture delivered at the Royal Institution, March 10, 1882.

electric current through it, although the current is uniform in every part, yet, as you see, the wire is not uniformly hot, but white-hot only in parts. The white-hot sections are platinum, the dark sections are silver. Platinum offers a higher degree of resistance to the passage of the electric current than silver, and in consequence of this, more heat is developed in the platinum than in the silver sections.

The high electrical resistance of platinum, and its high melting-point, mark it out as one of the most likely of the metals to be useful in the construction of incandescent lamps. When platinum is mixed with 10 or 20 per cent of iridium, an alloy is formed, which has a much higher melting-point than platinum; and many attempts have been made to employ this alloy in electric lamps. But these attempts have not been successful, chiefly because high as is the melting-point of iridio-platinum, it is not high enough to allow of its being heated to a degree that would yield a sufficiently large return in light for energy expended. Before an economical temperature is reached, iridio-platinum wire slowly volatilises and breaks. This is a fatal fault, because *in obtaining light by incandescence there is the greatest imaginable advantage in being able to heat the incandescing body to an extremely high temperature.* I will illustrate this by experiment.

Here is a glass bulb containing a filament of carbon. When I pass through the filament *one unit* of current, light equal to *two candles* is produced. If now I increase the current by *one-half*, making it *one unit and a half*, the light is increased to *thirty candles*, or thereabout, so that for this one-half increase of current (which involves nearly a doubling of the energy expended), *fifteen times more light* is produced.

It will readily be understood from what I have shown that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. We know of no metal that fulfils this requirement; but there is a non-metallic substance which does so in an eminent degree, and which also possesses another necessary quality, that of *low conductivity*. The substance is carbon. In attempting to utilise carbon for the purpose in question, there are several serious practical difficulties to be overcome. There is, in the first place, the mechanical difficulty arising from its intracability. Carbon, as we commonly know it, is a brittle and non-elastic substance, possessing neither ductility nor plasticity to favour its being shaped suitably for use in an electric lamp. Yet, in order to render it serviceable for this purpose, it is necessary to form it into a slender filament, which must possess sufficient strength and elasticity to allow of its being firmly attached to conducting wires, and to prevent its breaking. If heated white-hot in the air, carbon burns away; and therefore means must be found for preventing its combustion. It must either be placed in an atmosphere of some inert gas or in a vacuum.

During the last forty years, spasmodic efforts have from time to time been made to grapple with the many difficulties which surround the use of carbon as the wick of an electric lamp. It is only within the last three or four years that these difficulties can be said to have been surmounted. It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness, and possessing a great degree of elasticity and strength. Such filaments can be produced in various ways—by the carbonisation of paper, thread, and fibrous woods and grasses. Excellent carbon filaments can be produced from the bamboo, and also from cotton thread treated with sulphuric acid. The sulphuric acid treatment effects a change in the cotton thread similar to that which is effected in paper in the process of making parchment paper. In carbonising these materials, it is of course necessary to preserve them from contact with the air. This is done by surrounding them with charcoal.

Here is an example of a carbon filament produced from parchmientised cotton thread. The filament is not more than the *0.01* of an inch in diameter, and yet a length of three inches, having therefore a surface of nearly the one-

tenth of an inch, gives a light of twenty candles when made incandescent to a moderate degree.

I have said that, in order to preserve these slender carbon filaments from combustion, they must be placed in a vacuum; and experience has shown that if the filaments are to be durable, the vacuum must be exceptionally good. One of the chief causes of failure of the earlier attempts to utilise the incandescence of carbon was the imperfection of the vacua in which the white-hot filaments were placed; and the success which has recently been obtained is in great measure due to the production of a better vacuum in the lamps.

In the primitive lamps the glass shade or globe which enclosed the carbon filament was large, and usually had screw joints, with leather or india-rubber washers. The vacuum was made either by filling the lamp with mercury, and then running the mercury out so as to leave a vacuum like that at the upper end of a barometer, or the air was exhausted by a common air-pump. The invention of the mercury pump by Dr. Sprengel, and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under which a really high vacuum could be produced, and in fact gave quite a new meaning to the word vacuum. It was evident that the old incandescent lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon, its durability in a really high vacuum required still to be tested. This idea having occurred to me, I communicated it to Mr. Stearn, who was working on the subject of high vacua, and asked his co-operation in a course of experiments having for their object to ascertain whether a carbon filament produced by the carbonisation of paper, and made incandescent in a high vacuum, was durable. After much experimenting we arrived at the conclusion that *when a well-formed carbon filament is firmly connected with conducting wires, and placed in a hermetically sealed glass ball, perfectly exhausted, the filament suffers no apparent change even when heated to an extreme degree of whiteness.* This result was reached in 1878. It has since then become clearly evident that Mr. Edison had the same idea and reached the same conclusion as Mr. Stearn and myself.

A necessary condition of the higher vacuum was the simplification of the lamp. In its construction there must be as little as possible of any material, and there must be none of such material as could occlude gas, which being eventually given out would spoil the vacuum. There must besides be no joints except those made by the glass-blower.

Therefore, naturally and per force of circumstances, the incandescent carbon lamp took the most elementary form, resolving itself into a *simple bulb, pierced by two platinum wires supporting a filament of carbon.* Probably the first lamp, having this elementary character, ever publicly exhibited, was shown in operation at a meeting of the Literary and Philosophical Society of Newcastle, in February, 1879. The vacuum had been produced by Mr. Stearn by means of an improved Sprengel pump of his invention.

Blackening of the lamp glass and speedy breaking of the carbons had been such invariable accompaniments of the old conditions of imperfect vacua, and of imperfect contact between carbon and conducting wires, as to have led to the conclusion that the carbon was volatilised. But under the new conditions these faults entirely disappeared, and carefully conducted experiments have shown that well-made lamps are quite serviceable after more than a thousand hours' continual use.

Here are some specimens of the latest and most perfected forms of lamp. The mode of attaching the filament to the conducting wires by means of a tiny tube of platinum, and also the improved form of the lamp, are due to the skill of Mr. Gimingham.

The lamp is easily attached and detached from the socket which connects it with the conducting wires, and can be adapted to a great variety of fittings, and these

may be provided with switches or taps for lighting or extinguishing the lamps. I have here a lamp fitted especially for use in mines. The current may be supplied either through main wires from a dynamo-electric machine, with flexible branch wires to the lamp, or it may be fed by a set of portable store cells closely connected with it. I will give you an illustration of the *quality* of the light these incandescent lamps are capable of producing by turning the current from a Siemens dynamo-electric machine (which is working by means of a gas engine in the basement of the building) through sixty lamps ranged round the front of the gallery and through six on the table. (The theatre was now completely illuminated by means of the lamps, the gas being turned off during the rest of the lecture).

(To be continued.)

ANALYSIS OF POTASH MADE FROM KYATHOURG BAMBOO.

By R. ROMANIS, D.Sc.,
Chemical Examiner to Government, British Burmah.

It has been found that teak grows best when mixed with bamboo, but as the expense of the planting is great, it has been proposed to find some useful application for the bamboo in question that would defray part of the cost of its cultivation. With this end the officers of the Forest Department have been experimenting with a view of making potash from the ashes of the bamboo.

The following is an analysis of the crude potash:—

K ₂ O	.. .. .	43.12
KCl	.. .. .	8.65
Na ₂ O	.. .. .	2.51
CO ₂	.. .. .	11.96
SiO ₂	.. .. .	12.89
SO ₂	.. .. .	6.05
P ₂ O ₅	.. .. .	4.18
Al ₂ O ₃	.. .. .	1.90
H ₂ O	.. .. .	8.74
		100.00

RATIONAL METHOD FOR THE STUDY OF DYEING.

By M. DECAUX.

M. DECAUX, for forty-two years head of the Chemical Laboratory of the Gobelins, and for thirty-three years sub-director of the dyes under the direction of M. Chevreul, has aimed at summarising in the most concise manner the principles which ought to guide the pupil in the art of dyeing in the order of his work. He formulates here his views in order to establish their principles.

The pupil ought at the outset to know the elements of physics and chemistry, more thoroughly if they aim at becoming managers than if they are to be ordinary workmen. They should be naturally well organised, and have the sense of sight perfect and sensitive enough to distinguish colours among themselves, both as regards intensity and tone.

As a matter of course, persons affected with the defect of vision known as colour-blindness—which consists in confounding together different colours, such as red and green—can never engage with success in the arts which work with colours.

The pupil-dyers ought to know the principles of the contrast of colours, and especially of their mixture, or at least this science, still far from general, should be taught them at the outset.

On entering upon the practice of the art, and having as a basis a more or less complete knowledge of the nature of the materials upon which they have to fix colours, they will begin with those which are simplest, matching as well as possible the patterns given them.

Red, a simple colour obtained upon wool with cochineal fixed with tartar, tin-composition, and a small proportion of alum. Their preliminary studies will have made them acquainted with the composition and the reactions of these ingredients. Blue, obtained either with iron ferrocyanides or with extract of indigo. Lastly, yellow, a simple colour like the two former, produced with weld fixed by means of alum and a very small proportion of tartar.

These three colours are the types which by their mixture from all those which the pupil will in future have to produce.

He will then pass to the dyeing of the mixed colours, which may be reduced to three, and which, in opposition to the three simple colours above mentioned, may be called binary colours—viz., orange, composed of red and yellow; green, composed of yellow and blue; and violet, composed of blue and red. Here there arise sometimes incompatibilities of the means of fixing the two colours composing the mixture. Further, the variation of the proportion of the two simple colours which enter into the binary compound colour modifies its shade and augments the difficulties.

It is proper to pass to the dyeing of a colour in all its degrees of intensity from the lightest to the most intense. This assemblage of patterns when properly got up are all equidistant from each other in point of intensities, and may be more or less numerous. Each of them may be called a shade, and the whole a series.

The first shade of a series of colour borders more or less closely upon white, according to the number of shades in the series, and the last shade in like manner approaches closely upon black.

The difficulties of this work are in the proportion and the nature of the mordant or agent used to fix the colour, and of the colour itself for producing the shade; in the temperature required for fixation; and, in certain cases, in the nature of the material, wool, or silk, which having a slight orange tint, renders light blue shades greenish, and dims the beauty of light violets.

These various difficulties which exist in the series of the simple colours, red, yellow, and blue, are augmented in those of the binary colours—oranges, greens, and violets—from the necessity of keeping the two component colours always in the same proportion, so that the series may remain always regular, preserving the same tone in their whole extent. This extent—i.e., the number of shades in a series from white to black—varies with the interval which is made between two neighbouring shades, and their number will be so much the greater as these intervals are smaller.

The number of twenty shades seems most convenient, though series are sometimes made of thirty or forty shades.

When the six series are suitably made, the pupil will exercise himself in passing from each simple colour to the others, varying the proportions of the two. The red and yellow which, if mixed in proportions optically equal, yield an orange will give an orange-red if the proportion of the red is increased relatively to the yellow, and inversely an orange-yellow if the proportion of the yellow is increased relatively to the red. The intermediate tones take the names of:—

Red	R. 1, 2, 3, 4, 5
Red-orange ..	RO. 1, 2, 3, 4, 5
Orange	O. 1, 2, 3, 4, 5
Orange-yellow	OY. 1, 2, 3, 4, 5
Yellow	Y. 1, 2, 3, 4, 5

The intermediate tones between the yellow and blue are named yellow-green, green, blue-green. Between blue

and red—violet-blue, violet, red-violet, thus returning to red through the whole circuit of the spectral colours. We may thus draw up a chromatic table, either circular or rectangular, which latter form is more convenient for observation and matching-off.

The next lesson consists in mixing, not as heretofore two simple colours in various proportions, but two complementary colours, *i.e.*, three simple colours, for the complementary of a simple colour is always a binary. Thus red, a simple colour, has for its complementary green a compound of yellow and blue. Yellow has for its complementary violet, composed of red and blue. Blue has for its complementary orange, a compound of red and yellow.

In these mixtures there appears a new phenomenon: the new colour no longer, as in the mixture of two simple colours, participates in that of each of its components. It loses its lustre, is dulled and saddened, and when the three components are in equilibrium without any of them predominating, there is a complete extinction of colour, and the result is a grey. The study of these new mixtures which the pupil will undertake will be the most interesting part of all his labours, since the beauty of the colours which he will produce will often depend on his knowledge of these phenomena. He will therefore mix two complementary colours, *e.g.*, red and green in nine proportions—nine-tenths red with one-tenth green. The result will be a red slightly lowered by the grey resulting from the mixture of the green with a portion of the red: this grey lowers the remainder of the red. The second pattern will contain eight-tenths red and two-tenths green. The proportion of grey being augmented by the neutralisation of two-tenths of the red in place of one-tenth, as in the foregoing pattern, the resulting red will be still more lowered. It will be the same increasingly in the third and the fourth, whilst in the fifth the proportions of red and green neutralising each other reciprocally, the result will be a pure grey. Still further diminishing the proportions of the red, we obtain greens less and less lowered as we approach a pure green.

The same results are obtained by mixing yellow and violet or blue and orange. Lastly, two complementary colours may both be binary. The sum of the simple colour common to both being always the same, the one having more of what the other has less, thus a red-orange is complementary of a blue-green. The yellow contained in the former colour diminishes in the same proportion as it increases in the second. It is understood that the proportions one-tenth, two-tenths, &c., are neither ponderable nor volumetric, but simply optical. The passages through grey from one complementary colour lead naturally to the last patterns to be executed by the pupils who will have to produce a series of greys by the mixture of three simple colours. This series, when well drawn up, having its shades equally distant from each other, and all of a perfect grey without the predominance of any of its component colours, is the most difficult task which the dyer can undertake, and he will have the merit of obtaining a tone, the resistance of which to atmospheric injury will participate in that of its component colours.

This sum total of work, executed with different colouring matters upon different materials, will constitute the art of the dyer as derived from rational principles, which the dyer ought to comprehend fundamentally, and to carry out instinctively in practice.—*Bulletin de la Société d'Encouragement*.

Researches on the Formation of the Ptomaines.—MM. Paterno and Spica.—From the experiments of the authors it appears that the same substances, or substances similar to those known as ptomaines or cadaveric alkaloids, may be extracted from the animal fluids in a physiological condition, and before entering into putrefaction. This does not exclude, evidently, the formation of a new series of these substances.—*Moniteur Scientifique*.

RESEARCHES ON THE SUBSTITUTED BENZYL COMPOUNDS.

THE SYNTHESIS OF ANTHRACENE AND PHENANTHRENE
FROM ORTHO-BROM-BENZYL-BROMIDE.*

By C. LORING JACKSON and J. FLEMING WHITE.

(Concluded from p. 45.)

Discovery and Synthesis of Phenanthrene.

It is highly probable that Fritzsche,† in 1867, encountered phenanthrene in studying the higher fractions of coal-tar with his reagent, as he describes a hydrocarbon melting near 100°; this observation was entirely overlooked, however, and we owe the first definite statements about phenanthrene to Fittig,‡ who announced its discovery in August, 1872: but his preliminary notice of it was so imperfect that Glaser, who discovered it at about the same time, sent it to Graebe§ for investigation as a new hydrocarbon. In 1873 three independent tolerably complete accounts of it appeared almost simultaneously in the *Annalen der Chemie*; these were by Fittig and Ostermayer,|| by Graebe,¶ and by Hayduck.**

In Graebe's article the synthesis of phenanthrene by passing stilbene or dibenzyl through a red-hot tube is described, whereas Dreher and Otto,†† who tried the same experiment in 1870, before the discovery of phenanthrene, naturally overlooked it.

In the following year Graebe‡‡ added toluol to the substances which form phenanthrene under these conditions; and Barbier§§ announced that Fritzsche's phosene (see p. 44) was a mixture of anthracene and phenanthrene, since he succeeded in getting the characteristic test, brown plates, with Fritzsche's reagent (dinitro-anthraquinone) from such a mixture. Armed with this test, he then proceeded to examine the anthracenes from various syntheses, and found phenanthrene in those made by the action of heat on styrol and benzol, ethylene and benzol, benzyl-toluol, phenyl-xytol, and diphenyl-methane; also in the anthracene made from benzyl-chloride by heating with water, and in that from natural alizarine by reduction with zinc-dust; as in all these cases the phenanthrene could not be detected by any other test except Fritzsche's reagent, there seems good reason for receiving these results with caution, especially as he himself has proved by direct experiment|||| that anthracene cannot be converted into phenanthrene by heat. By passing a mixture of ethylene and diphenyl through a red-hot porcelain tube, however, he obtained a large quantity of phenanthrene, and also by heating liquid ditolyl or stilbene to dull redness in a sealed tube. Finally, Kramers¶¶ found a trace of phenanthrene among the products from passing phenol through a yellow-hot tube.

Constitution of Anthracene and Phenanthrene.

Dumas and Laurent, in their first article on anthracene, considered it a polymerised naphthalene. Anderson, after establishing the formula, called attention to the fact that anthracene and anthraquinone differed from stilbene and benzyl only by two atoms of hydrogen in each case. Berthelot, in 1867, on account of its formation from toluol at a red heat, gave it the formula—



* Presented to the American Academy. Communicated by the Authors.

† *Zeit. für Chemie*, 1867, 293.

‡ *Ber. Deut. Chem. Ges.*, 1872, 933.

§ *Ibid.*, 968.

|| *Ann. Chem. Pharm.*, 186, 361.

¶ *Ibid.*, 167, 131.

** *Ibid.*, 167, 177.

†† *Ibid.*, 154, 176.

‡‡ *Ber. Deut. Chem.*, 1874, 48.

§§ *Comptes Rendus*, 79, 121, 650, 820; also *Ann. Chim. Phys.*, series 5, 7, 515.

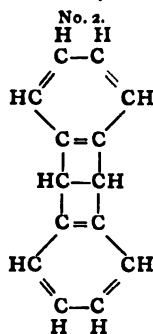
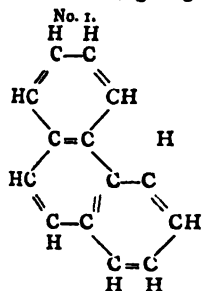
|| *Ann. Chim. Phys.*, 5, 7, 515.

¶¶ *Ann. Chem. Pharm.*, 189, 132.

*** Calculated to modern atomic weights.

which he showed later in the same year was supported also by Limpricht's synthesis, and his own decompositions of anthracene* with hydriodic acid; he considered it an "acetylo-diphenylene," but pointed out the fact that while the calculated boiling-point of this substance should be 310° to 320° , the boiling-point of anthracene is in reality 360° .

In 1870, Graebe and Liebermann proposed two formulæ for anthracene, giving the preference to No. 1, on the



ground of the syntheses by Limpricht from benzyl-chloride, and Berthelot from styrol and benzol; also because this formula is like that of naphthalene, which they show is allied to anthracene in many respects; but these arguments were overturned in 1872 by the discovery of phenanthrene, which not only resembled naphthalene more closely than anthracene did, but yielded diphenic acid and other undoubted derivatives of diphenyl, and was therefore entitled to the first formula, leaving the second for anthracene. This arrangement of the formulæ was confirmed by Van Dorp's synthesis of anthracene from benzyl-toluol, and by some experiments by Graebe,† which showed that phenanthrene-quinone gave diphenyl on distillation with soda-lime, while anthraquinone gave benzol and a very little diphenyl, indicating that there is no direct union of the rings in the latter.

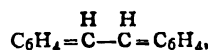
Finally the syntheses from phthalic acid, and the formation of phthalic acid by oxidation, or the action of sulphuric acid‡ on anthraquinone, established without doubt the ortho-position of the connecting atoms of carbon in one of the benzol rings of anthracene, which was still further confirmed by the syntheses from liquid benzyl-toluol and β -benzoyl-benzoic acid.

At the end of 1873, therefore, the second formula had been universally adopted as that of anthracene, although the position of the two connecting atoms of carbon in one of the benzol rings had not been determined, and the researches of following years, while confirming the points already established, threw no more light on this subject.§

With phenanthrene the case is different, as the proof of the ortho-position of the two additional atoms of carbon has not been neglected. In 1878, Schmitz|| argued that this was probably the constitution from the fact that diphenylene-ketone and diphenyl-carboxylic acid were completely destroyed by oxidation; while somewhat later in the same year the point was proved by Schultz,¶ and by Anschütz and Japp,** almost simultaneously. Schultz did this by converting Griess's meta-diamido-diphenic†† acid (made by the reduction of meta-nitro-benzoic acid with tin and hydrochloric acid) into di-iod-

diphenic acid, and reducing this to a diphenic acid, which he proved was identical with that from phenanthrene (a proof which he did not make perfectly satisfactory till a later paper,* in 1879). Anschütz and Japp oxidised the sodic salt of the phenanthrene-sulpho-acid with potassic permanganate, and obtained phthalic acid as the only product, whereas, if phenanthrene were not a diortho-compound, isophthalic or terephthalic acid must also have been formed.

In 1879, Merz and Weith† proposed a new formula for phenanthrene,—



founded on the fact that they obtained invariably perchlor-benzol instead of perchlor-diphenyl by the exhaustive action of chlorine upon it; the formation of diphenic acid would then be due to an atomic transformation during the process of oxidation. This hypothesis, however, can hardly be considered as throwing doubt on the constitution of phenanthrene until supported by additional facts, especially since Japp‡ has shown by the formation and properties of the β -phenanthrene-carboxylic acid that the C_2H_2 group behaves as if it were part of a benzol ring.

At present, then, the constitution of phenanthrene must be considered as settled, while it still remains to prove the position of the two connecting atoms of carbon on one of the benzol rings in anthracene.

Action of Sodium on Ortho-brom-benzyl-bromide.

In the hope of settling the constitution of anthracene we have studied the action of sodium on ortho-brom-benzyl-bromide, since this might lead to the formation of a hydride of anthracene by the union of two molecules, the side-chain of each being joined to the ring of the other, and of phenanthrene-dihydride if the two side-chains and the two rings were united. As these two reactions were likely to take place side by side, we expected that our product would consist of a mixture of these two hydrocarbons.

Ortho-brom-benzyl-bromide dissolved in anhydrous ether§ was warmed with sodium for some days; fresh shavings of sodium or sodium shot|| being added from time to time, until the bright surfaces were no longer tarnished. The greater part of the sodium was then removed, and, after treatment with dilute alcohol to destroy the remainder, the product of the reaction thoroughly washed with water; the yellowish viscous mass thus obtained was oxidised with chromic anhydride, and upon subliming the product, after removing the portions soluble in water and sodic hydrate, yellow needles were obtained which melted at 273° , and gave with zinc-dust and sodic hydrate a red colour; they were therefore anthraquinone.

0.5745 gr. of the substance gave on combustion 1.7000 grs. CO_2 and 0.2180 gr. H_2O .

	Calculated for $\text{C}_{14}\text{H}_8\text{O}_2$.	Found.
Carbon	80.75	80.67
Hydrogen	3.84	4.21

The anthraquinone was further converted into the bromine compound, which by fusion with potassic hydrate yielded alizarine.¶

A second portion of the ortho-brom-benzyl-bromide treated with sodium, and afterward freed from it in the same way, was distilled with steam for a long time, a white substance passed over, solidifying in part in the

* Bull. Chim. Soc., 9, 295.

† Ber. Deut. Chem. Ges., 1873, 63.

‡ Weith and Bindeschedler, *Ibid.*, 1874, 1106.

§ Anschütz (*Ibid.*, 1878, 1213) made diphenylene-ketone by heating anthraquinone with calcic oxide, but proves in the same paper that this reaction cannot be used as an argument in regard to the position of the C_2H_2 group in anthracene.

¶ Ann. Chem. Pharm., 193, 115.

** Ann. Chem. Pharm., 196, 1; Ber. Deut. Chem. Ges., 1878, 225.

†† Ber. Deut. Chem. Ges., 1878, 211.

‡‡ *Ibid.*, 1874, 1809.

* Ber. Deut. Chem. Ges., 1879, 235.

† *Ibid.*, 677.

‡ *Ibid.*, 1880, 573.

§ When toluol was used in place of ether, the reaction ran so slowly that even after boiling for several days the sodium was but little affected.

|| The sodium shot was made by melting sodium under toluol, and shaking (Wislicenus, *Ann. Chem. Pharm.*, 186, 212). It seemed to be not so effective as thin shavings of sodium.

¶ A preliminary notice of the work up to this point was published, Ber. Deut. Chem. Ges., 1879, 1965.

condenser, which was proved to be dibenzyl by its odour, its melting-point 52° , and the following analysis:—
0.2435 gr. of the substance gave on combustion with PbCrO_4 0.8240 gr. CO_2 and 0.1700 gr. H_2O .

	Calculated for $\text{C}_{14}\text{H}_{12}$.	Found.
Carbon.. ..	92.31	92.27
Hydrogen	7.69	7.75
	100.00	100.02

No anthracene-dihydride could be found in the distillate with steam, although it was carefully searched for.

The residue left in the flask, after the distillation with steam, was a yellow viscous mass, which can be most conveniently purified after distillation *per se*, as this destroys the greater part of the viscous substances containing bromine, which render the extraction with a solvent toilsome and unsatisfactory. The distillate, which passed over without a pause from 260° to redness, consisted of a solid mixed with oil, and had a very disagreeable rank smell, different from that of the undistilled substance. The less volatile parts of the distillate were easily converted by washing with alcohol and ether into white plates with a blue fluorescence, which melted at 212° , and were therefore *anthracene*. The residue left by evaporation of the alcoholic washings consisted of dibenzyl, a brown viscous substance containing bromine and a small amount of a yellow oil; it was tested for phenanthrene by oxidation with chromic anhydride in glacial acetic acid solution, and treatment of the product, after it had been freed from chromic compounds with water, and from acids by weak sodic hydrate, with warm acid sodic sulphite; the solution thus formed was filtered, acidified with hydrochloric (better nitric) acid, and allowed to stand for some time, when it deposited a yellow precipitate, which melted at 198° , and was therefore *phenanthrene-quinone*. For further confirmation it was tested, according to Laubenheimer,† as follows: A little of the substance was dissolved in about 5 c.c. of glacial acetic acid, a few drops of toluol, and 8 to 10 drops of sulphuric acid were added, and the mixture allowed to stand over night. It was then poured into water, which, shaken with ether, imparted to it a deep claret-red colour, exactly like that obtained from pure phenanthrene-quinone under the same conditions.

In a third experiment 20 grms. of ortho-brom-benzyl-bromide were treated with sodium for nearly a month in the way already described, but, instead of adding water at once to the product, the organic matter was extracted from the sodium and sodic bromide as far as possible with ether and benzol, in order to avoid the reducing action of the hydrogen set free by water. The residue insoluble in these solvents was finally treated with water, and the small amount of organic matter thus obtained added to that at first extracted. The amount of dibenzyl in this product was notably smaller than in those which had been treated directly with water. In a weighed portion an attempt was made to determine the amount of phenanthrene, by adding picric acid to a strong alcoholic solution, but no crystals of the picric acid compound of phenanthrene separated; the solution was therefore evaporated, and in this way a few red crystals were obtained, which had the form of the compound of anthracene with picric acid, and melted in the crude state near 168° instead of at 170° ; the quantity was too small to admit of purification. The formation of the anthracene compound, which is decomposed by alcohol, apparently from an alcoholic solution, can be explained by the supposition that it was not formed until the alcohol had evaporated, leaving the anthracene and picric acid dissolved in the oily impurities. In point of fact, it was obtained by imitating the above conditions; that is, evaporating an alcoholic solution of anthracene and picric acid, to which

a few drops of toluol had been added. The experiment would seem to show that phenanthrene as such does not exist in the original product.

To meet the objection which might be urged, that the anthracene obtained in the second experiment was not formed directly by the action of sodium on the ortho-brom-benzyl-bromide, but during the distillation of the viscous mass, which resembled the substance obtained by Zincke both from his reaction and the action of water at high temperatures on benzyl-chloride, another portion was treated with ether and hot alcohol, which removed a yellow oil and left *anthracene* identified by crystallising in white plates melting at 210° . The yellow oil contained either phenanthrene or its dihydride,* as it gave phenanthrene-quinone by oxidation, but we were unable to determine which of these substances was present on account of the small amount at our disposal. We are therefore in doubt as to the way in which the phenanthrene occurs in our product; for, on the one hand, we could not obtain the picric acid compound either from the original product or the yellow oil, while, on the other, a substance crystallising in plates melting between 170° and 190° , which has appeared more than once in the course of this work as an intermediate product in the purification of the anthracene, yields on oxidation anthraquinone and phenanthrene-quinone, and seems therefore to be a mixture of the two free hydrocarbons.

No anthracene-dihydride could be found in any of the products, nor have we succeeded in detecting benzyl-toluol or ditolyl, although it is highly probable that they were formed in addition to the dibenzyl; but the acids resulting from the oxidation appeared in such small quantities, and so contaminated with a brown impurity formed from the viscous brominated substance, that it was impossible to obtain any definite result from them. The viscous substances, too, containing bromine, which were the principal products of the reaction, have resisted thus far all our efforts to bring them into a form suitable for analysis, but we hope to return to this part of the subject hereafter.

Finally the following quantitative results were obtained:—

Organic product from 20 grs. ortho-brom-benzyl-bromide	10.85 grs.
Calculated product if free from bromine.. .. .	7.12 "
Bromine not removed by the sodium	3.73 "
Bromine in 20 grs. ortho-brom-benzyl-bromide	12.88 "
Bromine removed as bromide of sodium	9.71 "
Bromine not removed by the sodium	3.17 "

The "bromine removed as bromide of sodium" was determined by precipitating 7.727 grs. of the wash-water with argentic nitrate, which gave 1.482 grs. of argentic bromide. As the weight of the wash-water was 119 grs. this corresponds to the result given above. The two determinations of the amount of bromine not removed by the sodium agree as closely as could be expected when the losses resulting from the repeated extraction and washing of the viscous organic products are taken into account.

7.54 per cent of the whole amount of bromine contained in the ortho-brom-benzyl-bromide was therefore removed by the sodium.

Determination of the Amount of Anthracene by Luck's† Method.—1.04 grs. of the product, oxidised, first with chromic anhydride dissolved in glacial acetic acid, and afterward with an alkaline solution of potassic permanganate, gave 0.158 gr. of anthraquinone, corresponding to

* Owing to the ease with which the substance sublimes, great difficulty was encountered in getting a satisfactory combustion.
† *Ber. Deutsch. Chem. Ges.*, 1875, 224.

* Phenanthrene-dihydride has never been prepared with certainty although Barbier (*Comptes Rendus*, 79, 121) thought it was formed by the reduction of phenanthrene with sodium amalgam.
† *Zeit. Anal. Chemie*, 1873, 347; 1874, 251.

0.135 gr. of anthracene, that is, 1.409 grs. from the 20 grs. of ortho-brom-benzyl-bromide used, or 19.78 per cent of the theoretical yield.

Determination of the Amount of Phenanthrene.—2.44 grs. of the original product, oxidised carefully by adding a strong aqueous solution of chromic anhydride to a hot solution of the substance in glacial acetic acid as long as a drop of the oxidising agent made the liquid boil, on extraction of the product with acid sodic sulphite and acidification with nitric acid, yielded 0.05 gr. of phenanthrene-quinone, which corresponds to 0.0428 gr. of phenanthrene; that is, from 20 grs. of ortho-brom-benzyl-bromide 0.190 gr., or 2.66 per cent of the theory. The amount of phenanthrene actually formed must have been somewhat larger than this, as some of the quinone was undoubtedly destroyed by the chromic anhydride—in fact, the operation can hardly be called a quantitative one.

From the work described above, it appears that 20 grs. of ortho-brom-benzyl-bromide yielded,—

Total organic product	10.850 grs.
Anthracene	1.409 "
	9.441 "
Phenanthrene	0.190 "
	9.251 "
Dibrom-dibenzyl, or its isomers, calculated from 3.17 grs. of unremoved bromine	6.738 "
Undetermined, containing phenanthrene, dibenzyl, benzyl-toluol, and ditolyl ..	2.513 "

Summary of Results.

Ortho-brom-benzyl-bromide when treated with sodium yields anthracene (identified by its melting-point 212°, the formation of anthraquinone, melting-point 273°, and of alizarine; 19.78 per cent of the theoretical yield); and phenanthrene (identified by the melting-point of its quinone 198°, and by Laubenheimer's test; 2.66 per cent of the theoretical yield). Certainly part, and probably all, of the anthracene occurs in the free state; no anthracene-dihydride could be found. Our experiments leave us in doubt as to the way in which the phenanthrene occurs. Dibenzyl was also obtained, an oil possibly benzyl-toluol or ditolyl, and a viscous substance containing bromine.

By this synthesis of anthracene from ortho-brom-benzyl-bromide, it is proved that the two connecting carbon atoms are attached to each ring in the ortho-position, and thus the last doubt about the constitution of anthracene is removed.

The synthesis of phenanthrene, while it confirms the ortho-attachment of the two additional atoms of carbon, proves nothing either for or against the formula recently proposed by Merz and Weith.

The publication of the preliminary notice of this work, already mentioned, drew out an article from Von Pechmann,† describing work done at about the same time as ours, in which he applies to anthracene the ingenious method contrived by Graebe for determining the constitution of naphthalene as follows: Brom-ortho-benzoyl-benzoic acid, prepared by the action of brom-phthalic acid on benzol in presence of aluminic chloride, was converted into brom-anthraquinone by heating with sulphuric acid, which on fusion with potassic hydrate gave erythroxy-anthraquinone, and, as this when oxidised yielded phthalic acid, the conclusion drawn from our experiments that anthracene is a diortho-substance is confirmed by his work.—*American Chemical Journal*.

* Liebermann and Hormann, *Ber. Deutsch. Chem. Ges.*, 1879, 591.
† *Ber. Deutsch. Chem. Ges.*, 1879, 2124.

ANNUAL RECORD OF PUBLISHED SCIENTIFIC WORK.

THE following letter has been circulated by Mr. W. J. SOLLAS, Professor of Geology in University College, Bristol:—

"SIR,—I beg to bring before your notice a scheme for obtaining in a more effectual manner than hitherto a complete Annual Record of published Scientific Work. The disadvantages which attend the present absence of all system, notably the extravagant waste of time and labour involved, are so apparent as scarcely to need pointing out. That two Zoological Records should appear independently of one another, one at Naples and the other in London; that there should exist at least five or six Chemical Records all covering very much the same ground; more than one Geological Record, and in Physics no Record at all, at least in England; that some of these Records should be several years overdue, and others wanting in completeness, are anomalies which show the pressing need for reform.

"What is urgently required is some plan by which an Annual Record in each branch of Science may be obtained by the co-operation of scientific men all over the world. This would be most easily accomplished if—

- (I.) Each nation furnished a Record of its own work, and its own only.
- (II.) Each nation received the Records of every other nation in exchange for its own.

"Each nation being thus put in possession of Records from every part of the world would have but to classify and translate them in order to obtain, written in its own language, a complete systematic Record of the world's annual work in Science.

"To carry out this scheme would be required—

- (I.) National Committees.
- (II.) An International Congress.

"(I.) *The National Committees.*—These would each consist of a number of sections; one for each branch of Science, according to a classification, to be subsequently agreed upon. Their functions would be—

- (i.) To produce the National Records.
- (ii.) To receive and transmit Exchanges.
- (iii.) To arrange for Translations.
- (iv.) To superintend the Combination of the separate Records into a whole.

"(i.) The mode of obtaining a record of the work done in each country need not be discussed here, as it is a matter of detail which each Committee might best be left to determine for itself, aided in some respects as it might be by discussion in Congress.

"(ii.) The management of exchanges is a simple matter, merely involving the keeping by each Committee of a list of the head-quarters of all the rest, as well as the trouble and expense of postage.

"(iii.) The arrangements for translation would not be difficult. The translators would of course need to have some knowledge of science, if they were not actually scientific men, but there would probably be little difficulty in obtaining them, especially when it is considered that the main bulk of our scientific literature is furnished by English, French, and German-speaking peoples. The case is different with Russian and little-spoken languages, but the extra expense in procuring translators for them would be well compensated for by the wider recognition which the work published in these languages would obtain.

"iv. Finally, the union of the various Records into a whole remains to be considered, but this is so technical a matter, and can be accomplished in so many various ways, that it need not be discussed here. Each Committee would probably adopt a plan of its own, and probably no two plans would be exactly the same.

"(II.) *The International Congress.*—This would consist of representatives from each of the different National Committees. It would aim at securing so much uniformity as would be necessary for the successful working of the scheme, without interfering with the liberty of the Committees; and it would afford an opportunity for the interchange of ideas. Such a Congress might indeed be made a part of an International Association for the Advancement of Science,—an organisation for which the scientific world seems now to be waiting.

"The advantages of some such scheme as that just sketched out are great and obvious. It saves labour both by subdivision and by preventing the same thing from being done twice over or oftener, and by this economy is enabled to secure the maximum of efficiency at the minimum of expense.

"In conclusion, certain difficulties remain to be considered, and first with reference to expense. For it may be argued that a plan so extensive in its operations, involving so many combinations and so much labour, could not succeed unless directed by the most business-like management; and that such management could not be obtained for nothing, nor for a small sum. A post ill-paid is usually ill-served; and though it often happens that a small pecuniary payment is compensated for by payment of a quite different kind, yet that would evidently not be the case here. The officers of a recording system would have a thankless task, and would require to be paid for their labours. The saving effected by co-operation would, however, in some cases furnish a sum quite large enough for the adequate remuneration of abstractors, translators, editors, managers, and all concerned; in others it would possibly require to be supplemented by grants of money from Government or learned Societies. No doubt if the general scheme comes to be considered fully this question of expense will lead to another, and that is the rights of existing recording organisations. But the difficulties which this question would introduce should be capable of being met. For one thing it would obviously be to the advantage of the National Committees to make use, as far as possible, of the experience and organisation of existing corporations. These indeed would continue their work, though it might be somewhat changed in character and carried on under altered conditions.

"I intend to bring this scheme, worked out in greater detail, before the next meeting of the British Association for the Advancement of Science, but venture meanwhile to submit this outline to you in the hope of receiving suggestions, raising discussion, and if possible of obtaining your influence and support.

"University College, Bristol,
"July 24, 1882."

PROCEEDINGS OF SOCIETIES.

THE SOCIETY OF CHEMICAL INDUSTRY.

THE first Anniversary Meeting of this prosperous Society was held on the 5th ult. in the Chemical Theatre, Owens College, Manchester, under the presidency of Professor Roscoe. There was a large attendance of Members, among whom we particularly notice the presence of Professors Abel and Huntington, Messrs. Peter Spence, Ludwig Mond, G. E. Davis, E. K. Muspratt, and Dr. Hewitt. The progress of the Society has been most satisfactory. The number of members has risen to 1250, including a goodly number of the representative men of British chemistry, both pure and industrial. Two local sections have been formed—the Metropolitan, under the presidency of Prof. Abel, and the West Lancashire (Widnes, St. Helens, &c.), established by Mr. E. K. Muspratt. During the past year a Committee on the Patent Laws has been appointed, and has held various

meetings in the hope of this important subject being taken up by the Government. We learn that the majority of this Committee agrees substantially with the bill drawn up by the Society of Arts, and introduced into Parliament by Sir John Lubbock. Mr. Chamberlain, it appears, is about to bring in a bill on the same subject on the part of the Government, though when this will occur it would be very hazardous to predict.

Prof. Roscoe again referred at length to a most serious subject dealt with in his presidential address last year,—the fact that though the greater part of the raw materials, benzol, anthracene, &c., used in the manufacture of coal-tar colours is produced in this country, we yet import from Germany and Switzerland by far the largest quantity of the colours we consume, and thus lose the profit of an industry of about three millions sterling which should properly be ours. We have, in fact, almost every natural advantage for this manufacture. We have cheaper fuel and easier communication than our rivals; we produce more coal-tar than any other country in Europe, and none of the accessory materials are rendered dearer by fiscal regulations. Yet, in spite of all this, we are in effect unable to compete with Switzerland, which has to import its raw materials and to export its finished products by long and costly land- or river-transit! Making all due allowance for the circumstance that Switzerland has no patent laws, and that a manufacturer there may if so disposed pirate the inventions of other countries, whilst a foreigner may patent his processes here without any intention of working them on British ground, the one great cause of our comparative inferiority in the colour is too plain to be mistaken. Says Professor Roscoe—and we entirely agree with him—"The chief superiority which the German and Swiss undoubtedly possess over the English colour makers is to be sought in the thorough appreciation on the part of the foreigners of the value of, and the necessity for, scientific training and knowledge of the highest type in the conduct of their business. The German and Swiss colour maker—and to a great extent the same thing must be said of German and Swiss manufacturing chemists in general—is not content to manufacture a series of well-known products; he must constantly bring out novelties, and for this purpose he and his chemist must be educated up to the level of the science of the day. He must be able to understand and apply the discoveries of the purely scientific chemist, for these form the foundations of his trade." The necessity for such training, we are reminded, was long ago proclaimed by Liebig:—"It has taken a long time to convince technical men of the fact that they are bound to acquire the highest possible scientific education if they wish to understand their processes, and if they desire to start new manufactures and meet the ever-increasing demand for novelties."

Prof. Roscoe enforced his argument by an account of the colour works of Messrs. Bindschedler and Busch, of Bâle. Here the director is a thoroughly educated chemist, cognisant of and able to make use of the researches produced in the scientific laboratories of the world. Under him are three scientific chemists, to each of whom is entrusted one of the three departments into which the works are divided. These head chemists have been thoroughly trained at the Polytechnic School at Zurich, and each has several assistants under him. All these have had a thorough scientific education at a German University or in one of the Polytechnic Schools, such as those of Zurich, Aix-la-Chapelle, &c. Directly under these scientific assistants come the common workmen, who are simply machines carrying out the dictates of a higher intelligence. There are consequently, it would appear, no foremen who have risen from the ranks, and who have a rule-of-thumb knowledge of some particular part of the process. There are no fewer than ten well-fitted experimental laboratories, in which the head chemists and their assistants carry on investigations affecting either the production of new colours or the more economical manufacture of the old ones. "No sooner do the

results of any purely scientific research appear which may possibly yield practical results than the works' chemist scrutinises them, repeats them under modified conditions, so as at last to bring them within the limits of financial success. At some of the larger works, such as those of Hoechst and Ludwigshafen, the staff of well paid and thoroughly scientific chemists numbers from thirty to forty! This is a very great contrast to the state of things still too prevalent in England. In many works there is no scientific chemist at all, whilst in others we find one, whose time is wholly taken up with mere routine work, and from whom a degree of speed is demanded in analyses, &c., quite incompatible with accuracy, and which by fatal necessity leads to "cooking." Professor Roscoe, in closing his address, declares that the Germans and Swiss are before us—"Not only in the means of obtaining the highest technical training in their numerous universities and polytechnic schools, but what is more to the point, in the general recognition of the value and importance of such training for the successful prosecution of any branch of applied science." It must be remembered especially that the proprietors of such works are not, as too often with us, mere capitalists, or possessors of a bare routine knowledge of the business. They are, in the majority of cases, scientifically educated chemists who, if not personally engaged in research, can yet appreciate the work or even the suggestions of others.

A somewhat similar line of thought was worked out in a paper read by Mr. O'Neill on the "Chemistry of Calico Printing." He stated that many houses of the second class managed to get along without any skilled chemist, or even without a laboratory in which experiments could be made or colours tested. This lack of knowledge, it was contended, was a source of much loss. "It is impossible under such circumstances to determine whether or not colours, &c., supplied are genuine, and goods are often damaged in consequence. The impossibility of controlling the supply of drugs, from want of acquaintance with them, often leaves employers in the hands of dishonest servants."

It appears that certain prints had been sent in for exhibition by firms in the Lancashire district, and these were compared with some specimens of the work of M. Thierry-Mieg, of Alsace. On careful examination it was admitted that our home manufacturers had yet something to learn before they can produce the quality shown in the prints from Alsace. Indeed it is no secret to those connected with calico-printing that some of the more artistic patterns, especially those furnished by Continental designers, have to be either modified or abandoned in this country because their execution is found here practically impossible. No one surely can contend that this is a state of things with which we as a nation—and as a nation whose very existence turns upon industrial and commercial pre-eminence—ought to rest satisfied. One thing is at least certain: our rivals show no disposition to rest satisfied with what they have already effected. The CHEMICAL NEWS has long preached these lessons to inattentive hearers, and has sometimes been accused of a perverse disposition to undervalue British talent, skill, and practical utility. It is something to find our opinion now endorsed by the majority of those most interested and best able to judge.

Industrial Conditions of the Application of Cold for the Destruction of the Germs of Parasites in Alimentary Substances.—F. Carré.—Since M. Bouley's important communication concerning the action of cold on the trichinae, it has become important to ascertain the economic conditions of the question. Using the ammonia machine, the cost of treating 1000 kilos. of meat is 8 francs, or rather less than 0·01 franc per kilo. M. Bouley has disproved the common prejudice that frozen meat enters into putrefaction immediately after thawing.—*Comptes Rendus*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 2, July 10, 1882.

Certain Hydrates formed by Pressure and Release. MM. L. Cailliet and Bordet.—On compressing hydrogen phosphide in presence of water in the tube, which the first-named chemist has used in his experiments on the liquefaction of gases, and suddenly reducing the pressure, there is formed a white crystalline body which in a moment lines the inside of the tube. On completely removing the pressure this newly-formed body is dissociated. The compound obtained is probably a phosphonium hydrate. An apparently different body is obtained by treating a mixture of equal volumes of carbon dioxide and hydrogen phosphide in the same manner. Another compound is obtained from a mixture of hydrogen phosphide and carbon disulphide in presence of a little water. Others are formed from hydrogen sulphide and water, and from ammoniacal gas in presence of a saturated solution of this gas. The authors reserve to themselves the further examination of these compounds.

Conditions of Achromatism in the Phenomena of Interference.—A. Hurion.—This memoir does not admit of useful abstraction.

Apparatus for Registering in a Continuous Curve the Disengagement or Absorption of Gases, particularly those which Result from the Phenomena of Fermentation and of Respiration.—P. Regnard.—This memoir cannot be intelligibly reproduced without the two accompanying illustrations.

Reply to M. Berthelot's Paper "On the Electromotive Force of a Zinc-Carbon Element."—D. Tommasi.—It has been hitherto admitted that in any element the nature of the positive electrode had no influence on its electromotive force provided that such electrode was not attacked by the exciting liquid. It appears, therefore, that the increase of electromotive force which the author has shown in the zinc-carbon element is a novel fact and not without a certain scientific interest. It is not surprising that M. Berthelot has found by means of M. Mascart's electrometer that a zinc-carbon has an electromotive force greater than that of a zinc-platinum. It would have been very strange if M. Berthelot's determinations had proved the contrary. All the experiments which this *savant* has described (*Comptes Rendus*, July 3, 1882) in no way militate against the author's researches.

Basic Salts of Manganese.—Alex. Gorgen.—An account of three double salts formed by basic manganese sulphate with potassium, ammonium, and sodium sulphates.

Action of Bromine upon Quinoline and Pyridine.—E. Grimaux.—The author's object is to prepare the addition-products of bromine to quinoline and pyridine and to compare them with those furnished by cinchonine.

Researches on the Curves of Solubility in Water of the Varieties of Tartaric Acid.—E. Leidie.—The coefficient of solubility in water of the varieties of tartaric acid may be represented in a general manner by a function of the temperature:

$$\frac{ds}{dt} = A f(t),$$

in which A is a coefficient peculiar to each variety. The author gives in a table the solubilities of dextro- and levotartaric acid, of anhydrous and of hydrated racemic acid at 0°, 5°, 10°, &c., up to 100°.

Botanical, Chemical, and Therapeutic Researches on the Globulariae.—E. Heckel, J. Mourson, and F.

Schlagdenhaufen.—From the leaves of these plants the authors have obtained tannin, a colouring-matter, free and combined, cinnamic acid, and a glycol, which Walz has named globularine, and which yields a single decomposition product globularine. This latter substance, on treatment with caustic alkalies in heat, is converted into cinnamic acid.

Presence of a Glycol in Wine.—A. Henninger.—The substance in question is a butyl glycol.

Analyses of Waters from the Isthmus of Panama.—M. Aillaud.—The only remarkable feature in these waters is the presence of ruthenium in that of the Rio Grande.

Moniteur Scientifique, Quesneville.
June, 1882.

Alkaloids of the Cinchonas.—M. A. Hesse.—These two memoirs are translated from the Berlin *Berichte*.

Determination of the Alkaloids of the Cinchonas.—Dr. J. E. Vrig.—From the *Journal de Pharmacie et de Chimie*.

Determination of Phosphorus in Iron and Steel.—E. Agthe.—See vol. xlv., p. 284.

A New Alkalimetric Indicator: Determination of Carbonates in Caustic Solutions.—Prof. G. Lunge.—The substance of this paper has been already inserted.

Analysis of Wines.—Drs. Nessler and Barth.—From the *Zeitschrift für Analytische Chemie*.

Preparation of Sulphuryl Chloride.—Hans Schulze.—From the *Journal für Praktische Chemie*.

Certain Indigenous Drugs of India.—Prof. C. J. H. Warden.—From the *CHEMICAL NEWS*.

Preparation of Nitro-glycerin Compounds.—M. Dean.—The specification of the English patent No. 2226, A.D. 1881.

Industrial Society of Mulhouse.—Session of the Chemical Committee, April 13, 1882.—M. Albert Scheurer described to the Committee a new process for the fixation of certain colouring matters by the reduction of potassium chromate among the colour. The chromic oxide thus formed serves as a mordant upon which the colouring matter is fixed. The reduction of the chromate is effected by means of sodium sulphite or hyposulphite.

Journal für Praktische Chemie.
New Series. Vol. xxv., Part 7, 1882.

On the Compounds of the Mono and Bibasic Fatty Acids with Phenols.—M. Mencki.—In this fourth communication the author gives an account of cresol-aurine and orcin-aurine.

On the Admissibility of Plastered Wines.—M. Mencki.—The author thinks that the injurious nature of plastered wines containing more than 2 grms. per litre has not hitherto been proved by indubitable facts. It is, however, certain that "inconveniences" have been observed after the use of strongly plastered wines, and that the continued use of such wines may be injurious to health.

A Contribution to the Theory of Antisepsis.—Fr. Boillat.—The author replies to the conclusions of Dr. Koch that, of all the substances in repute as antiseptics, merely chlorine, bromine, iodine, mercuric chloride, and possibly potassium permanganate and osmic acid, deserve the name of disinfectants. He shows that agents which destroy the animal organism are applicable merely in the disinfection of lifeless objects. Albumen precipitated with phenol and washed certainly enters into putrefaction after 48 hours, but the author shows that the phenol is completely removed by washing. Metallic salts such as zinc chloride if applied to wounds produce instantly metallic albuminates, which, though they are not poisons for the Schizomycetes, afford them no suitable nourishment.

Chemical Analysis of the Oberbrunnen at Salzbrunn in Silesia.—R. Fresenius.—This paper is rather of medical than of chemical interest.

*Verhandlungen des Vereins zur Beförderung des
Gewerbleißes.* May, 1882.

This issue contains no chemical matter.

June, 1882.

Roasting Zinc Blende and Neutralising the Gases by means of Solution of Calcium Sulphide.—Dr. Kosmann.—The author first refers to Schnabel's process, in which the sulphuric and sulphurous acids of the gases from roasting metallic sulphides are absorbed by means of basic zinc carbonate, or by a mixture of zinc oxide with basic zinc sulphate. The process is technically successful, but the quantity of the absorbent material required is a fatal obstacle from a commercial point of view. For every per cent of sulphur in the blende which is roasted, two-and-a-half times the weight of zinc oxide must be used. Hence for a blende containing 40 per cent and 20 of sulphur, every kilo. requires 0.5 kilo. of zinc oxide. The removal and renewal or calcination of such quantities of the absorbent consumes too much labour and capital. The calcium sulphide process is described at length. The absorbent liquid is an aqueous solution of calcium monosulphide. It is found, however, that the product obtained by igniting a mixture of gypsum and coal contains not merely the mono-sulphide, but if it has been exposed to the air, polysulphides along with calcium hydrate. It has since been found preferable to prepare the solution by boiling sulphur with milk of lime. Here also polysulphides are present, but in a dilute lye, and in presence of calcium hydrate they pass into calcium sulph-hydrate. Along with the poly-sulphides calcium hyposulphite enters into solution, which also serves for the neutralisation of the sulphurous gases. The products of the absorption are free sulphur and gypsum. From 50 to 58 per cent of the sulphurous acid of the gases are absorbed.

OWENS COLLEGE, VICTORIA UNIVERSITY (MANCHESTER).—SESSION 1882-3.

1. DEPARTMENT OF ARTS AND LAW

2. DEPARTMENT OF SCIENCE AND ENGINEERING.

The SESSION will commence in these Departments on TUESDAY, October 3. Students will be admitted on and after WEDNESDAY, September 27. Candidates for admission must not be under Fourteen Years of Age, and those under Sixteen will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on SEPTEMBER 29.

3. DEPARTMENT OF MEDICINE AND SURGERY.

The SESSION will commence on MONDAY, October 2. Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

4. EVENING CLASSES.

The SESSION will commence on MONDAY, October 9. New Students will be admitted on WEDNESDAY, THURSDAY, and FRIDAY preceding, between half-past 6 o'clock and 9 o'clock P.M. Several ENTRANCE EXHIBITIONS are offered for competition at the beginning of the Session in Classics, Greek Testament, Mathematics, English, and History; and also a Dauntsey Medical Scholarship, value £100.

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ELECTRIC LIGHTING BY INCANDESCENCE.*

By JOSEPH W. SWAN.

(Concluded from p. 51.)

It is evident by the appearance of the flowers on the table that colours are seen very truly by this light, and this is suggestive of its suitability for the lighting of pictures.

The heat produced is comparatively very small, and of course there are no noxious vapours.

And now I may, I think, fairly say that the difficulties encountered in the construction of incandescent electric lamps have been completely conquered, and that their use is *economically practicable*. In making this statement I mean that, both as regards the *cost of the lamp* itself and the *cost of supplying electricity to illuminate it*, light can be produced at a cost which will compare not unfavourably with the cost of gas-light. It is evident that, if this opinion can be sustained, lighting by electricity at once assumes a position of the widest public interest, and of the greatest economic importance; and in view of this I may be permitted to enter with some detail into a consideration of the facts which support it.

There has now been sufficient experience in the manufacture of lamps to leave no doubt that they can be cheaply constructed, and we know by actual experiment that continuous heating to a fairly high degree of incandescence during 1200 hours does not destroy a well-made lamp. What the utmost limit of a lamp's life may be we really do not know. Probably it will be an ever-increasing span; as, with increasing experience, processes of manufacture are sure to become more and more perfect. Taking it, therefore, as fully established that *a cheap and durable lamp can now be made*, the further question is as to *the cost of the means of its illumination*.

This question in its simplest form is that of the more or less economical use of coal; for coal is the principal raw material alike in the production of gas and of electric light. In the one case the coal is consumed in producing gas which is burnt; in the other in producing motive power, and, by its means, electricity.

The cost of producing light by means of electric incandescence may be compared with the cost of producing gas light in this way:—2 cwts. of coal produce 1000 cubic feet of gas, and this quantity of gas, of the quality called 15-candle gas, will produce 3000 candle-light for one hour. But besides the product of gas, the coal yields certain by-products of almost equal value. I will therefore take it that we have, in effect, 1000 feet of gas from 1 cwt. of coal instead of from 2 cwts., as is actually the case.

And now, as regards the production of electricity. One cwt. of coal—that is, the same measure in point of value as gives 1000 feet of gas—will give 50 horse-power for one hour. Repeated and reliable experiments show that we can obtain through the medium of incandescent lamps at least 200 candle-light per horse-power per hour. But as there is waste in the conversion of motive power into electricity, and also in the conducting wires, let us make a liberal deduction of 25 per cent, and take only 150 candle-light as the nett available product of 1 horse-power; then for 50 horse-power (the product of 1 cwt. of coal) we have 7500 candle-light, as against 3000 candle-light from an equivalent value of gas—that is to say, two and a half times more light.

There still remains an allowance to be made to cover the cost of the renewal of lamps. There is a parallel expense in connection with gas lighting in the cost of the renewal of gas-burners, gas globes, gas chimneys, &c. I cannot say that I think these charges against gas lighting will equal the corresponding charges against electric lighting, unless we import into the account—as I think it right to do—the consideration that, without a good deal of expense be incurred in the renewal of burners, and unless minute attention be given, far beyond what is actually given, to all the conditions under which the gas is burned, nothing like the full light product which I have allowed to be obtainable from the burning of 1000 cubic feet of gas will be obtained, and, as a matter of fact, is not commonly obtained, especially in domestic lighting. Taking this into account, and considering what would have to be done to obtain the full yield of light from gas, and that if it be not done, then the estimate I have made is too favourable, I think but little, if any, greater allowance need be made for the charge in connection with the renewal of lamps in electric lighting than ought to be made for the corresponding charges for the renewal of gas-burners, globes, chimneys, &c. But it will be seen that, even if the cost for renewal of lamps should prove to be considerably greater than the corresponding expense in the case of gas, there is a wide margin to meet them before we have reached the limit of the cost of gas lighting.

I think, too, it must be fairly taken into account, and placed to the credit of electric lighting, that by this mode of lighting there is entire avoidance of the damage to furnishings and decorations of houses, to books, pictures, and to goods in shops, which is caused through lighting by gas, and which entails a large expenditure for repair, and a large amount of loss which is irreparable.

I have based these computations of cost of electric light on the supposition that the light product of 1 horse-power is 150 candles. But if durability of the lamps had not to be considered, and it were an abstract question how much light can be obtained through the medium of an incandescent filament of carbon, then one might, without deviating from ascertained fact, have spoken of a very much larger amount of light as obtainable by this expenditure of motive power. I might have assumed double, or even more than double, the light for this expenditure. Certainly double and treble the result I have supposed can actually be obtained. The figures I have taken are those which consist with long life to the lamps. If we take more light for a given expenditure of power, we shall have to renew the lamps oftener, and so what we gain in one way we lose in another. But it is extremely probable that a higher degree of incandescence than that on which I have based my calculations of cost may prove to be compatible with durability of the lamps. In that case the economy of electric lighting will be greater than I have stated.

In comparing the cost of producing light by gas and by electricity, I have only dealt with the radical item of coal in both cases. Gas lighting is entirely dependent upon coal,—electric lighting is not,—but in all probability coal will be the chief source of energy in the case of electric lighting also. When, however, water power is available, electric lighting is in a position of still greater advantage, and, in point of cost, altogether beyond comparison with other means of producing light.

To complete the comparison between the cost of electric light and gas light, we must consider not only the amount of coal required to yield a certain product of light in the one case and in the other, but also the cost of converting the coal into electric current and into gas; that is to say, *the cost of manufacture of electricity and the cost of manufacture of gas*. I cannot speak with the same exactness of detail on this point as I did on the comparative cost of the raw material. But if you consider the nature of the process of gas manufacture, and that it is a process, in so far as the lifting of coal by manual labour is concerned, not very unlike the stoking of a steam boiler, and if electricity is generated by means of steam, then the

* A Lecture delivered at the Royal Institution, March 10, 1882.

manual labour chiefly involved in both processes is not unlike. It is evident that in gas manufacture it would be necessary to shovel into the furnaces and retorts five or six times as much coal to yield the same light product as would be obtainable through the steam-engine and incandescent lamps. But here again it is necessary to allow for the value of the labour in connection with the products other than gas, and hence it is right to cut down the difference I have mentioned to half,—i. e., debit gas with only half the cost of manufacture, in the same way as in our calculation we have charged gas with only one-half the coal actually used. But when that is done there is still a difference of probably three to one in respect of labour in favour of electric lighting.

I have made these large allowances of material and labour in favour of the cost of gas, but it is well known that the by-products are but rarely of the value I have assumed. I desire, however, to allow all that can be claimed for gas.

With regard to the *cost of plant* I think there will be a more even balance in the two cases. In a gas-works you have retorts and furnaces, purifying chambers and gasometers, engines, boilers, and appliances for distributing the gas and regulating its pressure. Plant for generating electricity on a large scale would consist principally of boilers, steam-engines, dynamo-electric machines, and batteries for storage.

No such electrical station, on the scale and in the complete form I am supposing, has yet been put into actual operation; but several small stations for the manufacture of electricity already exist in England, and a large station designed by Mr. Edison is, if I am rightly informed, almost completed in America. We are therefore on the point of ascertaining, by actual experience, what the *cost of the works* for generating electricity will be. Meanwhile we know precisely the cost of boilers and engines, and we know approximately what ought to be the cost of dynamo-electric machines of suitably large size. We have therefore sufficient grounds for concluding that, to produce a given quantity of light electrically, the cost of plant would not exceed greatly, if at all, the cost of equivalent gas plant.

There remains to be considered, in connection with this part of the subject, the *cost of distribution*. Can electricity be distributed as widely and cheaply as gas? On one condition, which I fully hope can be complied with, this may be answered in the affirmative. The condition is that it be found practicable and safe to distribute electricity of comparatively high tension.

The importance of this condition will be understood when it is remembered that, to effectively utilise electricity in the production of light in the manner I have been explaining, it is necessary that the *resistance in the carbon of the lamps* should be relatively great to the *resistance in the wires which convey the current to them*. When lamps are so united with the conducting wire that the current which it conveys is divided amongst them, you have a condition of things in which the aggregate resistance of the lamps will be very small, and the conducting wire, to have a relatively small resistance, must either be *very short*, or, if it be long, it must be *very thick*, otherwise there will be excessive waste of energy; in fact, it will not be a practical condition of things.

In order to supply the current to the lamps economically there should be comparatively little resistance in the line. A waste of energy, through the resistance of the wire, of 10 or perhaps 20 per cent might be allowable, but if the current is supplied to the lamps in the manner I have described,—that of *multiple arc*, each lamp being as it were a *crossing between two main wires*,—then, and even if the individual lamps offered a somewhat higher degree of resistance than the lamps now in actual use, the thickness of the conductor would become excessive if the line was far extended. In a line of half a mile, for instance, the weight of copper in the conductor would become so great, in proportion to the number of lamps supplied

through it, as to be a serious charge on the light. On the other hand, if a smaller conducting wire were used, the waste of energy and consequent cost would greatly exceed that I have mentioned as the permissive limit.

Distribution in this manner has the merit of simplicity; it involves no danger to life from accidental shock, and it does not demand great care in the insulation of the conductor. But it has the great defect of limiting within comparatively small bounds the area over which the power for lighting could be distributed from one centre. In order to light a large town electrically on this system it would be necessary to have a number of supply stations, perhaps half a mile or a mile apart. It is evidently desirable to be able to effect a wider distribution than this, and I hope that either by arranging the lamps *in series*, so that the same current passes through several lamps in succession, or by means of *secondary voltaic cells*, placed as electric reservoirs in each house, it may be possible to economically obtain a much wider distribution.

Whether by the method of multiple arc, which necessitates the multiplication of electrical stations, or by means of the simple series, or by means of secondary batteries connected with each other from house to house in single series, the lamps being fed from these in multiple arc, I am quite satisfied that, comparatively with the distribution of gas, the distribution of electricity is sufficiently economical to permit of its practical application on a large scale.

As to the cost of laying wires in a house, I have it on the authority of Sir Wm. Thomson, who has just had his house completely fitted with incandescent lamps from attics to cellars,—to the entire banishment of gas,—that the cost of internal wires for the electric lamps is less than the cost of plumbing in connection with gas-pipes.

I have expended an amount of time on the question of *cost* which I fear must have been tedious; but I have done so from the conviction that the practical interest of the matter depends on this point. If electric lighting by incandescence is not an economical process, it is unimportant; but if it can be established—and I have no doubt that it can—that this mode of producing light is economical, the subject assumes an aspect of the greatest importance.

Although at the present moment there may be deficiencies in the apparatus for generating and storing electricity on a very large scale, and but little experience in distributing it for lighting purposes over wide areas, and consequently much yet to be learnt in these respects, yet, if once it can be clearly established that, light for light, electricity is as cheap as gas, and that it can be made applicable to all the purposes for which artificial light is required, electric light possesses such marked advantages in connection with health, with the preservation of property, and in respect of safety, as to leave it as nearly certain as anything in this world can be, that the wide substitution of the one form of light for the other is only a question of time.

Treatment of an Ore of Selenium (Zorgite) from the La Plata.—M. Billautot.—This ore is essentially a lead selenide, containing 30 per cent of selenium. It is finely powdered and treated with an *aqua regia*, composed of 5 parts of hydrochloric acid to 1 part nitric acid. The solution is concentrated at a gentle heat to expel the nitric and hydrochloric acids, the paste-like mass is taken up in water, which dissolves merely the copper chloride and the selenious acid, leaving lead chloride insoluble. This latter is washed methodically; the washings are added to the solution and the whole treated with a current of sulphurous acid, which throws down all the selenium as a red maroon deposit. This deposit is washed in water to remove copper chloride, boiled in a large platinum dish with pure hydrochloric acid to remove the last traces of lead chloride, washed with pure water, and melted in a graphite crucible. The price of selenium has fallen from 1000 to 40 frs. per kilo.—*Journ. de Pharm.*

ON CERTAIN SUBSTANCES OBTAINED FROM
TURMERIC.

I.—CURCUMIN.*

By C. LORING JACKSON and A. E. MENKE.

THE chemical study of curcumin, the yellow colouring-matter of turmeric, dates from a paper† by A. Vogel, Sr., and Pelletier, published in 1815, although even before this turmeric paper had been used as a test for alkalies, and its action with boric acid and various salts observed.‡ No analysis is given in this paper, and the low melting-point (40°) and description of the method of preparation show that the "yellow colouring-matter of turmeric" obtained by Vogel and Pelletier was principally composed of resin and turmeric oil; they proved, however, that it contained no nitrogen, and studied its action with alkalies, acids, and certain salts, especially acetate of lead.

In 1842, A. Vogel, Jr.,§ analysed a similar but perhaps somewhat purer preparation, which, however, must have consisted in great part of the yellow resin contained in the root, as it also melted at 40°; it is not wonderful, therefore, that his analyses led to no formula.

Passing over a number of unimportant notices,|| we come next to a paper by Schlumberger,¶ in which the action of a mixture of sulphuric and boric acids on crude curcumin is studied, and a description given of the product called by him roso-cyanin, because it dissolved in alcohol with a fine red colour, and was turned blue by alkalies. He also describes a resinous product of the action of boric acid on curcumin (pseudo-curcumin).

Two years later, in 1868, Bolley, Suida, and Lange** examined the turmeric oil, and published a new analysis of a purer curcumin (melting-point 120°); but it was not till 1870 that curcumin was obtained essentially pure. In this year Daube,†† Ivanow-Gajewsky,‡‡ and Kachler§§ published independent papers on the subject, of which Ivanow-Gajewsky's is entitled to the precedence, as the number of the *Berlin Berichte* which contained Daube's original paper gave a notice in the Correspondence of the reading of Gajewsky's paper before the Russian Chemical Society a month earlier. In addition to an analysis of the turmeric oil, he assigns, as the simplest possible, the formula $C_{16}H_{16}O$ to curcumin, which after crystallisation from ether or benzol melted at 172°. Daube, on the other hand, after extracting his curcumin with benzol, and purifying it by conversion into the lead salt, obtained the melting-point 165°, and the formula $C_{16}H_{16}O_3$. He also found that it was decolourised by sodium amalgam and alcohol, and converted into oxalic acid by dilute nitric acid.

Kachler, who did not succeed in crystallising his curcumin, although both Ivanow-Gajewsky and Daube got crystals, obtained the same formula as the former, that is, $C_{16}H_{16}O$, or some multiple of it. He also studied the action of sodium amalgam upon it, and that of hot zinc-dust, but with no very definite results in either case; whereas by fusing curcumin with potassic hydrate, he obtained proto-catechuic acid. From the turmeric oil he obtained essentially the same analytical results as Ivanow-Gajewsky.

* From the Proceedings of the American Academy. Communicated by the Authors.

† *Journal de Pharmacie*, 1, 289.

‡ Trommsdorff, *Trommsdorff's Journal von Pharm.*, 16, 96. Semendini, *Bibliothèque Britannique*, Jan., 1815.

§ *Journal de Pharm. et de Chimie*, sér. 3, 2, 20.

|| Deslozes, *Ann. Chim. Phys.*, 16, 76; A. Vogel, Jr., *Répert. Pharm.*, sér. 3, 3, 178; H. Rose, *Pogg. Ann.*, 102, 545; Lepage, *Archiv. der Pharm.*, sér. 2, 97, 240; Leube, *Vierteljahrsschr. Prakt. Pharm.*, 9, 393; Alex. Müller, *Journ. Prakt. Chem.*, 80, 119; Wittstein, *Vierteljahrsschr. Prakt. Pharm.*, 9, 282; Schützenberger, *Paraf. Mul. Soc. Bull.*, 1861, 503; Ludwig, *Archiv. der Pharm.*, 106, 169; Kraut, *Zeitschr. Anal. Chem.*, 4, 168.

¶ *Bull. Soc. Chim.*, sér. 2, 5, 194.

** *Journ. Prakt. Chem.*, 103, 474.

†† *Ber. Deut. Chem. Ges.*, 5, 609.

‡‡ *Ibid.*, 3, 624.

§§ *Ibid.*, 3, 713.

In 1872 Ivanow-Gajewsky published a second paper* on turmeric, containing another method for extracting curcumin, which, however, gave it a melting-point of 140°, and an analysis of the lead salt supporting his formula $C_{16}H_{16}O_4 (= (C_4H_4O)_4)$. Moreover, he confirmed the results of Kachler with fusing potassic hydrate (proto-catechuic acid) and zinc-dust, and states that the oil obtained with the latter is identical with turmeric oil, of which a new analysis is given, and its oxidation (yielding valeric and caproic acids) and action with phosphoric penta-chloride studied. He also prepared and analysed roso-cyanin, but was unable to find a satisfactory formula for it.

Finally, in 1873, he published the last paper† we have been able to find on this subject, in which he states that curcumin yields, on oxidation with potassic dichromate, terephthalic acid, and that roso-cyanin contains no boron, and, fused with potassic hydrate, yields para-oxy-benzoic acid.

In brief, the following facts had been established in regard to curcumin at the time that we began our research upon it:—Its formula was either $C_{10}H_{10}O_3$ or $C_{16}H_{16}O_4$; the highest melting-point observed was 172°; with alkalies it formed reddish brown salts; with boric and sulphuric acids, roso-cyanin; it was susceptible of reduction, and gave an oil with zinc-dust; by oxidation it yielded oxalic acid or terephthalic acid, and by fusion with caustic potash proto-catechuic acid.

Accordingly we first turned our attention to the determination of its formula.

Extraction and Purification of Curcumin.

After several experiments we have adopted the following method as the best and most convenient:—The turmeric oil is first removed from the ground root by treatment with ligroine;‡ then the curcumin, mixed with a large quantity of resin, is extracted with ether, and finally purified by crystallisation from alcohol.

The turmeric used by us has been principally Bengal turmeric, bought of Messrs. E. and F. King, of Boston; we have, however, also extracted enough of the Madras turmeric, the only other brand occurring in the Boston market, to assure ourselves of the identity of the curcumin obtained from both.

For a full description and history of turmeric, which consists of the root-stocks of the *Curcuma longa*, a plant of the ginger family, growing in India and other parts of the East, we would refer to Flückiger and Hanbury's "Pharmacographia,"§ and to a full botanical article recently published by A. Meyer|| in the *Archives de Pharmacie*.

The extractor was of the form recently described by Scheibler,¶ as this was the only one of which we have found a description adapted to the thorough extraction of large quantities of material; those forms in which the drug is not kept covered with the extracting liquid being apt to leave the edges partially unacted on. The only modification of Scheibler's apparatus made by us consisted in substituting a cylindrical tin vessel capable of holding 10 kilos. of ground turmeric for the smaller glass vessel used by him. With a cooler 78 c.m. long, the inner tube of which was a flattened U, also made of tin, the thorough extraction of the 10 kilos. of turmeric could be accomplished in little more than a fortnight. The solvent was removed, after it had ceased to act, by forcing out as much as possible of it by air pressure, and then distilling off the rest by filling with steam a jacket which surrounded the vessel containing the turmeric.

* *Ber. Deut. Chem. Ges.*, 5, 1103.

† *Ibid.*, 6, 196.

‡ In our first experiments we followed Ivanow-Gajewsky, and used carbonic disulphide for this purpose; but we have found that ligroine is not only much cheaper and more agreeable to work with, but yields a purer oil.

§ Macmillan and Co., London 1879.

|| *Archiv. Pharm.*, sér. 3, 18, 401.

¶ *Ber. Deut. Chem. Ges.*, 13, 338.

The ligroine extract yielded on evaporation a dark yellow oil, amounting on the average to 11 per cent of the weight of the root. The investigation of this substance will be described in a later paper.

The ether extract, a reddish brown mass, varying in consistency from semi-liquid to solid according to the period of the extraction at which it was obtained, was treated with successive small quantities of cold alcohol, which dissolved the viscous impurities more easily than the curcumin. In very obstinate cases washing with ether was found advantageous; if, on the other hand, the extract was comparatively free from resin, it could be washed with alcohol upon a filter. In either case the residue was purified by re-crystallisation from alcohol until it showed the constant melting-point 178° .

The average yield of curcumin was 0.3 of 1 per cent; this, however, is only the amount that can be extracted by the process just described; the quantity contained in the root is much larger, as a considerable amount remained mixed with the resinous impurities, and the green fluorescence of the crude turmeric oil pointed to the presence of some curcumin in this substance.

Composition of Curcumin.

The following combustions were made of the curcumin purified as just described and dried at 100° . In most of these analyses a slight ash was left, the amount of which has been subtracted from the weight of substance before calculating the percentages.

- I. 0.1106 grm. of substance gave 0.2774 grm. of CO_2 and 0.0563 grm. of H_2O . No ash.
- II. 0.2180 grm. gave 0.5450 grm. of CO_2 and 0.1099 grm. of H_2O . Ash 0.0007 grm.
- III. 0.2149 grm. gave 0.5376 grm. of CO_2 and 0.1090 grm. of H_2O . Ash 0.0006 grm.
- IV. 0.2195 grm. gave 0.5480 grm. of CO_2 and 0.1099 grm. of H_2O . Ash 0.0006 grm.
- V. 0.2743 grm. gave 0.6815 grm. of CO_2 and 0.1378 grm. of H_2O . Ash 0.0010 grm.

	I.	II.	III.	IV.	V.	Mean.
Carbon ..	68.43	68.39*	68.42*	68.27*	68.00	68.30
Hydrogen ..	5.65	5.62	5.69	5.59	5.60	5.63

All these analyses were made with curcumin from Bengal turmeric: I. and II. of different portions of the same sample, III., IV., and V. of different samples.

The following analysis was made of curcumin extracted from Madras turmeric:
0.3467 grm. gave 0.8612 grm. of CO_2 and 0.1870 grm. of H_2O . No ash.

Carbon ..	67.74
Hydrogen ..	5.99

The sample analysed was very red, and the somewhat lower percentage of carbon obtained was undoubtedly due to the presence of an impurity which causes the curcumin to crystallise in red burrs, as is shown by the following analysis of a very red sample of Bengal curcumin:

0.2168 grm. of substance gave 0.5400 grm. of CO_2 and 0.1057 grm. of H_2O . No ash.

Carbon ..	67.93
Hydrogen ..	5.42

It is to be observed, however, that enough of this impurity to change the crystalline habit and colour of the curcumin has but a very slight effect on the percentage composition, and, it may be added, does not lower the melting-point more than one degree. That it is formed by the oxidation of curcumin by the action of the air, appears from the fact that pure yellow curcumin was partially converted into red burrs when moistened with

* These numbers become, if the ash is not subtracted from the weight of the substance:

	II.	III.	IV.	V.
Carbon ..	68.17	68.23	68.09	67.75
Hydrogen ..	5.60	5.64	5.58	5.58

alcohol and exposed to the air for a long time. When once formed, the impurity can be removed only by repeated crystallisation, and the amount of Madras curcumin at our disposal did not admit of this, nor did we take the trouble to prepare a larger supply, as the above analysis with the melting-point 178° is sufficient to establish the identity of the Madras and Bengal curcumins.

The following comparison shows that our results agree tolerably well with those of Daube, but are entirely at variance with those of Kachler and Ivanow-Gajewsky. (As no analyses are given in the abstract of the latter's article, which alone is at our disposal, we have given the theory for his formula, $\text{C}_{16}\text{H}_{16}\text{O}_4$, under his name.)

	Ivanow-Gajewsky.	Kachler.	Daube.	Jackson and Menke. Mean.
Carbon ..	70.58	69.90	69.87	67.90
Hydrogen ..	5.90	5.70	5.59	5.76

There are, then, eight analyses of curcumin which support a percentage of carbon in the neighbourhood of 68, against three (or more) in favour of one near 70.*

It is probable that the high results obtained by Ivanow-Gajewsky and Kachler were due to the presence of resinous impurities, since their predecessors, who analysed exceedingly impure curcumin, as shown by the low melting-point, obtained the following results:

	A. Vogel, Jr.	Bolley, Suida, and Lange.
Carbon ..	69.50	69.07
Hydrogen ..	7.46	6.40

This view is further supported by the fact that we obtained a higher melting-point, 178° , than any one else; Daube found 165° , Ivanow-Gajewsky 172° , later 140° , while Kachler gives no melting-point, and did not succeed in obtaining his curcumin crystallised. In view of these facts we feel no hesitation in rejecting all the previous analytical results except those of Daube.

Daube gives curcumin the formula $\text{C}_{10}\text{H}_{10}\text{O}_3$, but our results, and for that matter his, agree much better with the formula $\text{C}_{14}\text{H}_{14}\text{O}_4$, as appears from the following comparison:

	$\text{C}_{10}\text{H}_{10}\text{O}_3$.	$\text{C}_{14}\text{H}_{14}\text{O}_4$.	Daube.	Jackson and Menke.
Carbon ..	67.42	68.29	67.90	68.30
Hydrogen ..	5.62	5.69	5.70	5.63

We have therefore adopted the formula $\text{C}_{14}\text{H}_{14}\text{O}_4$, which is also confirmed by the analyses of derivatives of curcumin to be given later in the paper.

(To be continued.)

ACTION OF ALUMINIUM UPON CUPRIC CHLORIDE.

By Dr. D. TOMMASI.

ALUMINIUM reacts briskly upon cupric chloride, even at the ordinary temperature, the products being hydrogen, metallic copper, and an aluminium oxychloride, the composition of which varies according to the degree of concentration of the copper solution. If again aluminium is caused to react in heat upon a solution of these oxychlorides there is obtained as final product a compound of the formula $\text{Al}_2\text{Cl}_6(\text{Al}_2\text{O}_3\text{H}_2\text{O})_6.12\text{H}_2\text{O}$.

The following is the process which the author has followed for the preparation of this oxychloride:—He adds an excess of aluminium to a solution containing 31.25 per cent of CuCl_2 ; when the copper is precipitated he filters, and adds to the filtrate a few fragments of aluminium,

* Ivanow-Gajewsky obtained a percentage of lead in a plumbic salt agreeing with his combustion; but this result is more than counterbalanced by the analyses of derivatives of curcumin given later in this paper.

and heats on the sand-bath. This reaction is effected in a flat-bottomed flask with a long neck, fitted with a small funnel. When the liquid is heated the aluminium begins to dissolve with an escape of hydrogen. Towards 70° the reaction is brisk, and becomes violent at 100°. When all the aluminium is dissolved a fresh quantity is added, until it ceases to dissolve even at a boiling-heat.

A little water must be added from time to time to preserve the liquid at the same volume. When the reaction is at an end the liquid is filtered. This solution of oxychloride does not crystallise, and to obtain it in a solid state it is first evaporated to a syrup in the water-bath, then spread out upon a plate of glass, which is heated in the stove to between 40° and 50°. The oxychloride thus obtained is in the form of white scales resembling potassium borico-tartrate. When dried at 100° this compound contains 14.93 per cent chlorine and 27.69 per cent aluminium. The solution of this oxychloride, like ferric oxychloride, possesses the singular property of being precipitated by the addition of sulphuric acid or of certain salts. A single drop of concentrated sulphuric acid occasions a precipitate of hydrated alumina so copious that the whole liquid gelatinises. The hydrated alumina thus obtained is sparingly soluble in sulphuric acid, which makes the author suppose that it is not ordinary alumina, but an isomeric modification of the trihydrate.—*Les Mondes*.

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

THIS research was undertaken in compliance with the instructions of a letter from the President of the National Board of Health, written on behalf of the Executive Committee of the Board, and dated Washington, December 29, 1880.

A full report on the objects, in detail, of the investigation, on the methods employed, and the results obtained, has been prepared and placed in the hands of the Board. Pending its publication *in extenso*, the Executive Committee has thought proper to direct that an abstract, covering the principal conclusions reached, shall be published. The following presents such an abstract:—

It was intended to examine carefully the chief processes in use for chemically determining the organic matter, or its constituents, in drinking-water, to test the absolute and relative accuracy of the results these processes are capable of yielding, and as far as possible to ascertain the nature and scope of the practical conclusions available for sanitary purposes which may thence be secured.

Three chemists took charge severally of the so-called "combustion process" of Frankland and Armstrong, the "albumenoid-ammonia process" of Wanklyn, Chapman, and Smith, and the "permanganate process" originally suggested by Forchhammer, in the form advocated and minutely described by Tidy. These gentlemen, Mr. W. A. Noyes, Dr. Charles Smart, U.S.A., and Dr. J. A. Tanner, U.S.N., worked independently, the first in the laboratory of the Johns Hopkins University at Baltimore, by permission of its authorities; the second at the office of the National Board of Health, in Washington; and the third in the laboratory of the University of Virginia. Arrangements were made to have the samples of water for examination collected, and distributed to these three points by myself, so that there should be identity of material submitted to each analyst, and all three analysts should examine their several samples on the same day. Prof. H. Newell Martin, of the Johns Hopkins University,

kindly undertook a simultaneous microscopic examination of the waters placed in the hands of the chemists, as also a series of pathological observations on the effect of injecting the waters, concentrated by evaporation at very low temperature, beneath the skin of rabbits, whose temperature and general condition were compared with those of like animals not so treated.

A large amount of preliminary and special work was done in the early part of 1881, the former chiefly with a view to making the analysts thoroughly familiar with the processes to be tested before coming to the actual tests themselves, the latter on various modifications of the processes in detail, and incidental points in connection with them of sanitary interest. From this work a number of results of considerable interest have been obtained, but their publication will have to be made in their place in the general report.

For the main series of test analyses the following classes of waters were obtained or prepared:—

Class I.—Natural waters, believed from actual use to be of good wholesome character, including the regular water supply of some of the principal cities of the United States.

Class II.—Natural waters which there seems to be fair ground for believing have actually caused disease on the part of those drinking them. A request for information as to such waters, and for samples of them, was published for several months in the *National Board of Health Bulletin*, and was extensively copied into newspapers and professional journals, and a copious correspondence with physicians and others in various parts of the country was employed to secure such samples, and to sift the evidence as to the supposed connection of the use of each water with the production of disease.

Class III.—Natural waters, of doubtful, but more or less suspected, character. In reference to these the medical evidence was insufficient to justify placing them in Class II.

Class IV.—Artificially prepared waters, made by adding to good wholesome water determinate amounts of various infusions of *vegetable* organic matter, of natural origin, and of such kinds chiefly as water for human consumption is liable to be brought in contact with.

Class V.—Artificially prepared waters, made as above, with various forms of *vegetable* refuse from manufacturing or industrial operations.

Class VI.—Artificially prepared waters, as above, made with *animal* (or partly animal) organic matter of natural origin, especially such as are likely to occur in connection with the contamination of drinking-water.

Class VII.—Artificially prepared waters, as above, made with *animal* refuse from manufacturing or industrial operations.

Class VIII.—Artificially prepared waters, as above, to which had been added morbid products from certain diseases in the human subject.

Class IX.—Solutions, in distilled water, of carefully determined amounts of pure substances of definite chemical composition.

The results obtained from the examination of a large number of samples, representing the above classes of waters, are given in detail in a table in the general report. At present the conclusions reached in the discussion of these results can alone be given.

GENERAL DISCUSSION OF RESULTS.

Degree of Accuracy of the three Principal Processes Examined.—This may be looked at in two ways:—First, as to the concordance of the results obtained by each process in duplicate or triplicate experiments on the same water; and, secondly, as to the agreement of the results obtained with the actual contents of a particular water when these are quantitatively known.

In the former of these aspects we have to do with such errors as are, practically speaking, fortuitous; in the

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

latter we notice especially the indications of constant errors inherent in the methods used.

Extent of Concordance of the Results obtained by each Process in Multiplied Experiments on the same Water.—This has been tested by taking the mean of duplicate or triplicate determinations, noting the difference between this mean and each of the individual determinations on which it was based, and calculating this difference as percentage on the mean itself. The data for such calculation have been most numerous in the case of the combustion process, since it was considered necessary to make duplicate analyses all through the research, with a number of triplicates. It is the more important that this process should be thus examined, in view of the objection which has been often made to it, that it demands an unusual degree of skill and

training on the part of the experimenters. In connection with the extensive work of the English Commission on the Pollution of Rivers, it is to be supposed that many duplicate analyses must have been made by this method, but there has appeared but little in print to show how far these were concordant. The results obtained in the course of the present research are summarised in Tables XI., XII., and XIII.

TABLE XI.—Extent of disagreement of results of multiplied analyses of same water by combustion process.

	Divergence of Individual Results from Mean, as percentage on mean.		
	Greatest.	Least.	Avg.
For all waters in Classes I. to VIII. inclusive, save the few for which there was but one analysis and those for which there was a known source of error vitiating one of the analyses.*			
Organic carbon.. . . .	24.46†	0	4.24
Ditto, rejecting twelve cases in which the divergence was over 10 per cent (ten of these cases involved very minute absolute quantities of carbon)	9.96	0	2.89
Organic nitrogen	40.00‡	0	9.48
Ditto, rejecting thirteen cases in which the divergence was over 20 per cent (ten of these cases involved very minute absolute quantities of nitrogen)	19.82	0	7.09
For the waters in Class IX. (solutions of definite chemical substances in known amount. §)			
Organic carbon.. . . .	50.00||	0.15	9.54
Ditto, rejecting six cases in which the divergence was over 10 per cent (four of these cases involved very minute absolute quantities of carbon)	7.76	0.15	2.81
Organic nitrogen	14.52¶	0	5.05
Ditto, rejecting five cases in which the divergence was over 10 per cent (but one of these cases involved a very minute quantity of nitrogen)	9.75	0	2.71
Average of both the above sets of experiments, giving them equal weight.			
Organic carbon (including all cases)	37.23	0.07	6.89
Ditto (rejecting in all thirty-six extreme cases, as above) ..	8.86	0.07	2.85
Organic nitrogen (including all cases)	27.26	0	7.26
Ditto (rejecting in all thirty-six extreme cases, as above) ..	14.78	0	4.90

* Representing in all two hundred and sixty-two separate analyses for carbon and two hundred and forty-six for nitrogen. (Some analyses for the latter element were vitiated by uncertainty in the determination of free ammonia, and hence in the amount to be subtracted for this latter.)

† Actual difference was less than 0.3 milligram.

‡ Actual difference was only 0.04 milligram.

§ Representing in all forty-one separate analyses each for carbon and nitrogen. (One determination for each was without a duplicate, and hence had to be rejected from the data for this table.)

|| Actual difference was 0.035 milligram.

¶ Actual difference was 0.47 milligram.

TABLE XII.—Extent of disagreement of results of multiplied experiments on same water by albumenoid-ammonia process.

	Divergence of Individual Results from Mean, as percentage on mean.		
	Greatest.	Least.	Avg.
For thirteen waters in Classes I. to VIII. examined in triplicate.*			
Free ammonia	36.05	0	3.91
Ditto, rejecting two cases involving very minute quantities of free NH ₃	19.05	0	2.79
Albumenoid ammonia	8.51	0	2.69
For waters of Class IX. (twenty-one in all—all examined in duplicate).†			
Free ammonia	5.53	0	1.67
Albumenoid ammonia	14.28	0	6.19
Ditto, rejecting four cases involving very minute quantities of alb. NH ₃	12.79	0	4.56
Average of both the above sets of experiments, giving them equal weight.			
Free ammonia (including all cases)	20.79	0	3.79
Ditto (rejecting two extreme cases, as above)	12.29	0	2.23
Albumenoid ammonia (including all cases)	11.39	0	4.44
Ditto (rejecting four extreme cases, as above)	10.65	0	3.62

* Representing thirty-nine separate determinations.

† Representing forty-two separate determinations; of course purely negative results are not included in the data for this table.

TABLE XIII.—Extent of disagreement of results of multiplied experiments on same water by the permanganate process.

	Divergence of Individual Results from Mean, as percentage on mean.		
	Greatest.	Least.	Avg.
For twelve waters in Classes I. to VIII., examined in duplicate.*			
Oxygen consumed in 1 hour†..	4.70	0	1.09
Oxygen consumed in 3 hours‡	4.35	0	0.56
For waters of Class IX. (twenty-one in all, all examined in duplicate).§			
Oxygen consumed in 1 hour||..	8.33	0	0.62
Oxygen consumed in 3 hours¶	6.66	0	1.10
Average of both the above sets of experiments, giving them equal weight.			
Oxygen consumed in 1 hour ..	6.51	0	0.85
Oxygen consumed in 3 hours ..	5.50	0	0.83

* Representing twenty-four separate determinations.

† Including five cases in which divergence was over 1 per cent (in all these but very little oxygen was consumed).

‡ Including two cases in which divergence was over 1 per cent (in these very little oxygen was consumed).

§ Representing forty-two separate determinations. Of course those are not included in the data for this table which showed no oxygen, or but a mere trace, consumed.

|| Including one case in which divergence was over 1 per cent (very little oxygen consumed).

¶ Including three cases in which divergence was over 1 per cent (very little oxygen consumed).

Of the figures given in the last column of Table XI. those which probably represent with most fairness the average departure from the mean of an individual determination by the combustion process* are—

	Per cent.
For organic carbon	2.89
For organic nitrogen	7.09

This goes in part to support the opinion of Tidy,† that the results of the combustion process are less to be relied on for nitrogen than for carbon.

The results shown for the waters of Class IX. are less deserving of attention in this particular respect, since there were but seven different organic substances included, and these specially selected. The reversal of position of the carbon and nitrogen results in this class, as compared with the preceding, is partly due to great and variable loss by evaporation of the volatile organic acids, and by dissociation of the salts of the amines, &c.

From the last column of Table XII. the figures which probably may most fairly be taken to represent the average divergence from the mean of a single determination by the albumenoid-ammonia process are—

	Per cent.
For free ammonia	2.23
For albumenoid ammonia	3.62

We should naturally expect to find greater irregularity in the evolution of the so-called albumenoid ammonia, though the conditions of chemical action be made as nearly as possible the same.

As regards the averages in the last column of Table XIII. the consumption of oxygen by the waters in Class IX. having been for the most part very small, it seems probable that, for practical purposes, the first figures may best be taken, viz.—

	Per cent.
For oxygen consumed in one hour	1.09
For oxygen consumed in three hours	0.56

showing somewhat greater irregularity in the early stage of the action than later.

It will be seen that on the whole the most closely concordant results were furnished by the permanganate process, and the least so by the combustion process, the albumenoid-ammonia process holding the intermediate position.

Extent of agreement of the results obtained by the different processes with the quantities of organic constituents known to be actually present.—The detailed evidence under this head is given in columns 19 to 23, inclusive, of the last sheet of Table X., in which the results actually obtained on examination of the waters in Class IX. (solutions of known amounts of certain organic substances of definite chemical composition) are compared with the amounts of the organic elements really present and the calculated amounts of oxygen required for their complete oxidation.‡ The following summary (in Table XIV.) presents the conclusions reached within the limits of these experiments.

The figures of this table strikingly indicate certain important defects of the several processes, although they must be looked at in a broad, general way, remembering the small number of organic substances treated, and their special characters.

As regards the combustion process we find loss of carbon in all cases considerable, and in some cases very great, with a strong tendency on the whole to excess of nitrogen,

TABLE XIV.—Extent of agreement of results obtained by the different processes with the known chemical character of the waters in Class IX.

	Amounts obtained, as percentage upon Amounts Calculated.		
	Grat.	Least.	Average.
Combustion process.			
Organic carbon	85.0	1.0	53.0
Organic nitrogen (including that of ammonia)	180.0	47.0	118.0
Albumenoid-ammonia process.			
Grat. Least. Average.			
Nitrogen of free			
NH ₃ *	94.0	0	(28.0)†
Nitrogen of alb.			
NH ₃ *	84.0	0	(24.0)† 95.0 0 53.0
Permanganate process.			
Oxygen consumed in 1 hour	13.0	0	3.0
Oxygen consumed in 3 hours	16.0	0	4.0

(In this Table, as in the last sheet of Table X., a considerable fraction of 1 per cent is represented by 1—; an insignificant fraction is considered =0.)

* Both calculated as percentage on total nitrogen present.

† These two averages have no real significance.

which in some cases is very great. It is of course easy to see how, in large measure at least, these errors were caused for some of the samples. Thus, doubtless, free butyric and valerianic acids were formed from their salts, and volatilised with the water during its evaporation; the salts of the amines probably suffered partial dissociation, with volatilisation of the bases, and urea was lost after conversion into ammonium carbonate. It may be objected that such substances as these ought not to have been selected. But it is to be remembered that every one of them occurs among the products of putrefactive decay of albumenoid or other organic matter, and hence may fairly be looked for among the constituents of organically polluted water.*

The occurrence of loss of organic constituents during the evaporation of water for the combustion process has often been suspected by the critics of that process,† and often, though sometimes cautiously, denied by its advocates. Thus Mills has said‡—"Substantially satisfactory evidence has been adduced that there is no material loss during the evaporation." The experiments now reported prove exactly the reverse of this, and furnish for the first time, as far as I know, direct evidence of the fact that, for some organic substances at least, and those of a kind liable to occur among the products of putrefaction, there is material, nay very great, loss.

As regards the frequently presented excess of nitrogen, I am strongly inclined to believe it, in part at least, due to absorption, during the evaporation of the acidified water, of ammonia from the atmosphere surrounding the gas flame and water-bath. Due care was taken as to the general condition of the atmosphere of the room, and it hardly seems possible to account for the error from this source.§ But anyone who has noticed the considerable deposit of ammonium sulphate formed on platinum vessels over an ordinary laboratory lamp, or on bells suspended over household gas-lights, will readily admit that here is a manifest source of danger. The extent to which ammonia is removed from coal-gas at different works, and in the same works at different times, varies no doubt a good deal, but all American gas which

* See Mills's conclusions from a much more limited basis of induction furnished by a few of Frankland's analyses.—*Journ. Chem. Soc. (Lond.)*, February, 1878; 58 *et seq.*

† *Journ. Chem. Soc. (Lond.)*, January, 1879; 56.

‡ In this calculation hydrogen has been taken as converted into water, carbon into carbon dioxide, and nitrogen as evolved in uncombined form; of course no one would expect any such ultimate results of oxidation from the action of the permanganate as practically applied. Frankland, in a similar calculation (*Journ. Chem. Soc., Lond., March, 1866*; 83), seems to have taken the nitrogen as oxidised to nitric acid.

* Fresenius and Scherer have found butyric and propionic acids in the mineral water of Brückenau and Weilbach. *Zeitschrift für Anal. Chem.*, 20; 3; 325.

† Wanklyn asserts in the most positive way the occurrence of loss, but gives no experimental evidence in support of his assertion. ("Water Analysis," London, 1879; 190.)

‡ *Journ. Chem. Soc. (Lond.)*, February, 1878; 58.

§ The most scrupulous pains, too, were taken to guard against leakage of air into the Sprengel vacuum and nitrogen from the cupric oxide, and errors from these sources could scarcely have failed to be detected. They were examined into over and over again.

I have examined readily shows its presence. With the gas in use at the University of Virginia and the neighbouring town of Charlottesville, I find that when not ignited it will in five seconds produce a distinct yellow stain on a drop of the Nessler reagent upon white filtering paper, and, although no doubt much ammonia undergoes combustion when the coal-gas itself is burning, a platinum capsule of 3 inches in diameter, containing water to keep it cool, will, if held over the flame of a Bunsen burner for half a minute, and the outside surface then washed off into a test glass, yield a liquid which distinctly gives the Nessler reaction for ammonia. During the many hours of the evaporation of a water sample there must occur in the atmosphere about the water-bath a quantity of nitrogen in the form of ammonia which may well be called very large in comparison with the amounts dealt with by the water analyst, and although contact of the contents of the glass dish with this atmosphere is largely cut off by the glass shade, such contact is not entirely prevented, as there is the notch in the rim of the water-bath for the passage of the feed-flask neck. The avidity with which such ammonia as may reach the acid water will be absorbed by it is obvious enough, even though some be afterwards lost by dissociation. The excess of nitrogen observed in the analyses of Class IX. seems to be general; even in those cases in which a loss is recorded it will be noticed that this loss is always less than for the carbon of the same substance, and the result is most probably a mere balance between two errors in opposite directions, actual loss of organic nitrogen volatilised in some form during the evaporation of the water, very possibly to even a greater extent than for carbon, and on the other hand absorption of nitrogen as ammonia from the atmosphere.

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 3, July 17, 1882.

Lightning Rods.—M. Melsens.—The author defends his system of lightning rods, which consists of a kind of cage formed of multiple conductors. He refers to an experiment which has been considered capital by many physicists and which supports those of Faraday, proving that no electric manifestation is possible in a cage with continuous metallic sides, or metallic meshes, placed in perfect communication with a common reservoir. Any animal is placed in a hollow sphere of metallic links, placed upon or suspended from the coating of a strong Leyden battery. The attempt is then made to strike the animal by the discharge of the battery, but it experiences no action from a spark which would have been dangerous or mortal if it were not protected by the cage. In this experiment the metallic cage represents the author's lightning rod, and the animal within represents a house with its inhabitants and the inflammable matter which it may contain.

Hydrated Hydrogen Sulphide.—M. de Forcrand.—With reference to the memoir of MM. Cailliet and Bordet (*Comptes Rendus*, July 10), the author points out that he has previously indicated the formation, composition, &c., of the hydrate in question in a note presented to the Academy in April (*Comptes Rendus*, xciv., p. 967), and which now appears in detail in the *Annales de Chimie et de Physique*. He has produced compounds of the same order by the union of water, hydrogen sulphide, and a number of organic substances.

Limits of Nitrification of Cellulose.—M. Vieille.—The author has experimented on the results obtained by treating cotton with nitric acid at different degrees of concentration. A very slight decrease in the specific gravity of the acid greatly modifies the nature of the product. The limits between which he obtained compounds capable of yielding collodion are very narrow. Trinitro-cellulose is completely soluble in acetic ether, and completely insoluble in a mixture of alcohol and ether. The collodion cottons are readily soluble in both, whilst the lower compounds are unaffected by both, behaving in this respect like crude cellulose.

Influence of the Compressibility of Elements on the Compressibility of the Compounds into which they enter.—L. Troost.—The variation of the coefficient of compressibility of the vapour of iodine recurs in that of mercury iodide.

Derivatives of the Cuprous Sulphites.—A. Etard.—The author recently described two simple isomeric cuprous sulphites, establishing their differences by their physical properties. He now studies their chemical properties, and finds them connected with two distinct series of double salts.

Gastric Juice.—P. Chapoteau.—The author examines a white pulverulent body obtained by mixing the aqueous solution of the gastric juice with an equal volume of alcohol at 95°. This body, which ought to be called pepsine, is found in the gastric juice as a potassium salt.

Products of the Distillation of Colophonium.—A. Renard.—By operating upon large quantities of the crude essence, the author has extracted a superior homologue of heptene, which passes over between 120° and 132°, and which when purified may be represented by the formula C_8H_{14} . This carbide the author names octene.

A New Class of Cyanic Compounds with an Acid Reaction, Cyano-malonic Ether.—A. Haller.—The compound is colourless, of a pungent odour, and an acid reaction. If exposed to the air, it turns slightly reddish. It is slightly soluble in water, to which it gives an acid reaction, and is soluble in alcohol, ether, and alkaline solutions. It decomposes carbonates with escape of carbonic acid. Its formula is $C_8H_{11}NO_4$. The author has prepared a number of its salts.

Two New Antiseptics, Calcium and Sodium Glycoborates.—G. Le Bon.—The author asserts that these bodies whilst being powerfully antiseptic have the properties of being very soluble, inodorous, and not poisonous. Thus they may be employed for the preservation of articles of food.

Industrial Conditions of the Application of Cold for the Destruction of the Germs of Parasites in Alimentary Substances.—F. Carré.

Verhandlungen des Vereins zur Beförderung des Gewerbflusses. Supplemental Volume, 1882.

This volume contains a lengthy survey of the special technical schools of Europe and America. Its extent, 150 quarto pages, renders abstraction impossible.

Bulletin de la Société Chimique de Paris.
May 20, 1882.

Specific Heat of Hyponitric Acid.—MM. Bertholet and Ogier.—The substance of this memoir has already appeared in the *Comptes Rendus*.

Industrial Residue Rich in Selenium, and a New Process for its Extraction.—M. P. Kienlen.—Amongst the secondary products from which selenium is extracted, the text-books mention especially the flue-dust from metallurgical works in which seleniferous ores are treated, and the deposits formed in the lead-chambers where pyrites are burnt containing traces of selenium. Another

residue rich in selenium is the deposit formed in the Wolff's bottles in which hydrochloric acid is condensed. It is derived from the volatilisation of the selenium contained in the sulphuric acid used for the decomposition of the salt. In large chemical works the acid generally employed for this purpose is that which flows from the Glover tower, and which is rendered unfit for the production of strong acid by the presence of a large proportion of iron. In the Glover tower the selenious acid derived from the pyrites is reduced by the sulphurous acid to selenium, which is either dissolved in the acid or remains suspended. The proportion of selenium thus retained is often, in works where the pyrites of Saint Bel, near Lyon, are burnt, large enough to give a blood-red tinge to the acid. The determination of the selenium is easily effected by operating upon considerable quantities, diluting with three times their volume of water, and then allowing them to settle for a long time in a warm place. The clear liquid is then drawn off with a syphon, and the deposit of selenium is collected on a tared filter, washed, and dried at about 100°. Acid from the Glover tower (sp. gr. 1.606) has thus given per litre 28.3 m.grms. and chamber acid (sp. gr. 1.532) 34 m.grms. per litre. Selenium being volatile at dull redness is often swept away by the hydrochloric vapours during the calcination of salt-cake, and is deposited in the first condensers. The hydrochloric acid is sometimes so loaded that it presents a fine red fluorescence, and the glass connection-tubes are lined with a layer of selenium several millimetres in thickness. The mud deposited in the condensers when dried at 100° give a proportion of selenium varying from 41 to 45 per cent. The determination is effected in the following manner:—20 grms. of dried mud are placed in a long-necked flask, stirred up in water, and mixed with caustic soda-lye till the reaction is slightly alkaline. Bromine is then added drop by drop, shaking continually till no further rise of temperature is produced. After a time the mixture is filtered, and the filtrate, mixed with the washing waters, is heated to a boil with a small quantity of hydrochloric acid, and the selenium precipitated by sulphurous acid is collected on a tared filter and weighed. For the industrial extraction of selenium from this deposit, the mud is stirred up in water, and treated in the cold with chlorine in a series of large Wolff's bottles. The selenium is converted into tetrachloride, which in presence of water gives selenious acid, and this again is partially transformed by the excess of chlorine into selenic acid. The resulting solution is strongly acid, and contains selenious, selenic, and hydrochloric acids. When the brick-red colour has completely disappeared from the first bottle it is withdrawn and its place is taken by the second, whilst the last bottle receives fresh mud. The deep black liquids are filtered through felt fitted to frames, and are then raised to a boil in presence of an excess of hydrochloric acid, which reduces the selenic acid to selenious acid with disengagement of chlorine. The liquid is then made up to its original volume, and the selenium is precipitated in large stoneware vessels by means of sodium bisulphite, which is added till a strong odour of sulphurous acid is perceptible. The selenium falls in large crimson flakes, which collect into a pitchy mass with bronze reflections. It is raised to a boil by blowing in steam, and the precipitate quickly collects at the bottom of the vessel as a steel-grey mass.

Action of Aluminium upon Cupric Chloride.—D. Tommasi.—Already noticed.

Artificial Production of Crystalline Carbonates: Witherite, Strontianite, and Calcite.—L. Bourgeois.—The author obtains these bodies in crystals by the dry way, under the ordinary pressures and in certain fluxes, of which a mixture of sodium and potassium chlorides, in equal equivalents, gives the best results.

Artificial Production of Analcime.—A. de Schulten.—The author mixes solutions of sodium silicate and alumina in proper proportions, adds a suitable quantity of

lime-water, and heat for eighteen hours to 180° in a closed copper-tube.

Determination of Nitric and Nitrous Nitrogen as Ammonia.—A. Guyard.—Already noticed.

Artificial Production of a Crystalline Hydrated Silicate.—A. de Schulten.—The author has obtained a zeolite approaching in composition to okenite.

Tetranitrated Ethylen Bromide.—A. Villiers.—Already noticed.

Chloruration of Camphor: Formation of Dichlorated Camphor.—P. Cazeneuve.—Already noticed.

Physiological Action of Beta-Collidine.—MM. Marcus and Oechsner de Coninck.—This alkaloid, though derived from cinchonine, is strongly poisonous. Subcutaneous injections of 0.05 to 0.15 grm. occasion a general and progressive debility, and paralyse the action of the psycho-motor centres.

Journal für Praktische Chemie.

New Series. Vol. xxv., Part 8, 1882.

Contributions to the Chemistry of the Chrome-Ammoniacal Compounds.—S. M. Jörgensen.—The author treats here on the normal and the basic rhodochromates.

Contributions to the Chemistry of the Rhodium-Ammoniacal Compounds.—S. M. Jörgensen.—The author has had the opportunity of examining the ammoniacal rhodium compounds and finds them completely analogous with the ammoniacal compounds of cobalt and chromium. Rhodium ammonia chloride, $10\text{NH}_3\text{R}_2\text{Cl}_6$, corresponds in every respect to the chloropurpureo-chlorides of cobalt and chromium. It is insoluble in hydrochloric acid. Only four atoms of chlorine are precipitated by salts of silver in the cold, and the remaining two only on prolonged boiling. It is precipitated by nitric acid, a yellowish white chloropurpureo-nitrate being deposited. The author has demonstrated the existence of bromo-, iodo-, and nitrate-purpureo-rhodium salts as well as of roseo- and xantho-rhodium salts.

The Elementary Composition of Starch.—F. Salomon.—Pure potato-starch is composed according to the elementary formula $\text{C}_6\text{H}_{10}\text{O}_5$. The formula proposed by Naegeli must be rejected.

The Constitution of Isatogenic Ether.—H. Kolbe.—A critique on a passage of a memoir by Prof. Ad. Baeyer.

Justus Liebig's Annalen der Chemie,
Band 212, Hefte 1 and 2.

Reduction Experiments in the Anthraquinon Series.—C. Liebermann.—In this extensive memoir the author treats successively of the reduction of anthraquinon, of quinazoline, and of oxy-anthraquinon; of chrysarobine, a naturally occurring reduction-product of chrysophanic acid; the reduction of sulphanthraquinonic acid, anthrol, and anthramine; of the alkylised reduction stages of anthraquinon, the alkyloxanthrols, and their derivatives; the alkyl-hydro-anthranols, and alkyl-anthracenes. As the treatise extends to some 120 pages, no useful abridgment is practicable.

Certain Derivatives of Para- and Ortho-nitro-Cinnamic Acid.—C. L. Müller.—The author describes the preparation of nitro-cinnamic acids, the bromation of both the nitro-cinnamic esters, the treatment of para-nitro-phenyl-dibrom-propionic ethyl-ester with alcoholic potassa, para-nitro-mono-brom-cinnamic ethyl-ester, the preparation of para-nitro-phenyl-propionic acid, the treatment of ortho-nitro-phenyl-dibrom-propionic ester with alcoholic potassa, ortho-nitro-phenyl-propionic acid, ortho-nitro-phenyl-acetylene, the results of the reduction of ortho-nitro-phenyl-propionic acid, i.e., the production of indigo-

tine. It appears that the author made this observation without being aware that Prof. Baeyer had come upon the same reaction. It appears from the author's results that by the introduction of the nitro-group into the benzol nucleus of cinnamic acid, the tendency of the latter to combine with negative radicals, and to pass into a saturated compound, is considerably weakened. These researches were conducted during the winter term of 1879-80, and the summer term of 1880, in the Laboratory of the Technical High School at Munich, and were laid before the Philosophical Faculty of the University of Freiburg, in December, 1880, as an Inaugural Dissertation.

Derivatives of Para-nitro-cinnamic Acid.—V. B. Drewsen.—This memoir contains accounts of para-nitro-cinnamic acid, of its dibromide, the dibromide of para-nitro-cinnamic ethyl-ether, para-nitro-phenyl-propionic acid, its dibromide, the dibromide of its ethyl-ether, para-nitro-phenyl-acetylene, para-nitro-aceto-phenon, and para-amido-aceto-phenon.

Cotarnine (Second treatise).—E. von Gerichten.—We have here an account of tarconic acid, tarnine, nartine, nartinic acid, methyl-brom-tarconium-iodide, ethyl-brom-tarconium-iodide, the action of hydrated baryta upon methyl- and ethyl-brom-tarconium-iodide, and upon the hydroxides corresponding to these iodides, methyl-brom-tarconic acid, ethyl-brom-tarconic acid, and cupronine.

Combinations of the Elements of the Nitrogen Group with the Radicles of the Aromatic Series.—A. Michaelis.—In this fifth treatise the author, with the assistance of Cl. Paneck, discusses the homologues of phosphenyl chloride, the tolyl-phosphorus chlorides, para- and ortho-tolyl-phosphor-tetra-chlorides, para-tolyl-phosphor-oxy-chloride, tolyl-phosphinous acid with its salts, benzo-phosphinous acid, the xylyl-phosphor-compounds, including xylyl-phosphor-chloride and xylyl-phosphinous acid.

Communication from the University Laboratory of Würzburg.—This consists of a memoir by J. Wislicenus on the evaluation of the adhesive energies of the halogens and sodium to organic residues. The following are the chief conclusions reached: With the equal organic residues the adhesive energy of chlorine is the greatest, and that of iodine the smallest. Among the compounds of the same halogen with isomeric radicles, the primaries have the smallest, and the tertiaries the greatest powers of adhesion. The adhesive energy of iodine, and doubtless of the other halogens, to alcohol radicles of the same category increases with increasing molecular weight.

Preparation of Etylen-diamine and certain of its Properties.—Communicated by K. Kraut from the experiments of O. Rhousopoulos and F. Meyer.—Etylen-diamine hydrate does not mix with benzol and ether, and cannot be withdrawn from its aqueous solutions by means of ether. The boiling-point is 118° , and the sp. gr. 0.970 at 15° . In freezing mixtures it congeals to a crystalline mass, which melts at $+10^{\circ}$. Its composition may be represented by $\text{C}_2\text{H}_4(\text{H}_2\text{N})_2\text{H}_2\text{O}$.

Journal de Pharmacie et de Chimie.
June, 1882.

Action of Potassium Cyanide upon Potassium Trichloracetate.—E. Bourgoin.—Already noticed.

Chloruration of Camphor: Formation of Camphor Bichloride.—P. Cazeneuve.—Already noticed.

Caffeine.—M. Tanret.

Purification of Zinc Sulphate.—H. Prunier.—The author peroxidises the iron present by means of potassium permanganate. To ascertain the quantity necessary, he dissolves 10 grms. of copperas in water slightly acidulated with sulphuric acid, and pours into this liquid a solution

of permanganate (1-1000th) until a permanent rose tint is produced. Suppose that the 10 grms. of copperas have consumed 22 c.c. of the permanganic liquid, or 0.022 gm. of potassium permanganate. If we wish to purify 100 grms. of zinc sulphate, we must dissolve these 100 grms. in 200 of water, add 0.22 gm. permanganate also dissolved in water, and complete the precipitation of the manganese and the iron by pouring into the mixture liquid ammonia diluted to 1-10th, so as to form a little zinc oxide; 5 c.c. are sufficient. The whole is boiled for some minutes, let settle, and if the supernatant liquid is not quite colourless a few more drops of dilute ammonia are added. It is then boiled again, let cool, filtered, and the filtrate concentrated, avoiding a boiling heat.

Detection of Lead in Tin Paper.—A drop of concentrated acetic acid is let fall upon the suspected leaf, and a drop of a solution of potassium iodide is added. If there is lead present there is formed in two or three minutes a yellowish spot of lead iodide. Kopp moistens the leaf to be examined with sulphuric acid. If the tin is pure the spot remains white, but if lead is present there is formed a black spot.

Malic Acid in the Berries of the Mountain Ash.—E. Johanson.—These berries are richest in malic acid when of a yellowish orange colour. When still green or when fully ripe the proportion is less.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., April, 1882.

Memoir on Hydrocellulose and its Derivatives.—Aimé Girard.—Under the influence of acids, both mineral and vegetable, both dilute and concentrated, and in variable conditions of temperature and time, cellulose, $\text{C}_{12}\text{H}_{20}\text{O}_{10}$, before becoming saccharified, and even before taking the state of soluble cellulose, is transformed into a new compound, $\text{C}_{12}\text{H}_{11}\text{O}_{11}$, exceedingly friable, but retaining many of the properties of normal cellulose. The conversion is most easily effected by immersion for twelve hours in sulphuric acid at sp. gr. 1.420. The author remarks that Mercerised fibres present the same physical state as those treated with acids. Hydrocellulose possesses special tinctorial aptitudes. It takes up readily colours which can only be fixed upon normal cellulose with great difficulty.

Normal Carbonic Acid of the Atmosphere.—M. Dumas.—The author, whilst admitting that the proportion of carbonic acid in the atmosphere varies little from 3 parts in 10,000, proposes systematic determinations made at different points of the globe.

Rational Method for the Study of Dyeing.—M. Decaux.—(See p. 51).

May, 1882.

This issue contains no chemical matter.

Annales de la Société des Sciences Industrielles de Lyon.
No. 1, 1882.

Note on the Manner of Determining the Composition of Tissues made of Different Fibres.—H. Danzer.—The author separates animal from vegetable fibre by the well-known process of boiling with a caustic alkaline lye.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Extracting Tannin.—Can any correspondent inform me of an economical process of extracting tannin from bark so as to save bulky carriage?—BALA, Merionethshire.

THE CHEMICAL NEWS.

VOL. XLVI. No. 1186.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Cobalt.—However slight the proportion of cobalt, caustic potassa does not give very good results in consequence of the relatively considerable entanglement of gallium in the oxide precipitated. Sensible traces of gallium may be detected in cobalt oxide which has been precipitated with an excess of potassa five times in succession, and this when operating upon a liquid containing merely 0.005 grm. gallium in 2 to 3 grms. of cobalt oxide. Yet, after the seventh potassic treatment, there no longer remains any gallium in the oxide of cobalt. The process is therefore only fit for removing small quantities of cobalt mixed with much gallium; the small precipitate of cobalt oxide is then freed from the last traces of gallium by one of the other methods. The potassic filtrates often retain a trace of cobalt, which tinges them blue; exposure to the air decolourises these solutions in one or two days in the cold, or in one hour with heat, brown cobalt oxide being deposited.

Barium and calcium carbonates effect at first merely an imperfect separation of gallium and cobalt. Even in the cold, after a contact of six hours, the precipitates contain notable quantities of cobalt oxide. Contrary to what happens with the salts of zinc, the author finds a little more cobalt oxide in the precipitate with the calcium than in that with the barium salt. The inconvenience of the precipitation of a certain quantity of cobalt oxide in presence of barium and calcium carbonates is diminished by the separation which is naturally effected between gallium and cobalt, when ammoniacal boiling or treatment with cupric hydrate are employed to eliminate calcium and barium salts.

In the reaction of calcium carbonate in heat, after sulphurous reduction, there are also deposited notable quantities of cobalt oxide, which, nevertheless, are entirely eliminated if the operation is repeated once or twice, and also on ammoniacal ebullition or treatment with copper hydrate for the removal of lime. Prolonged boiling after supersaturation with ammonia enables us to separate very conveniently gallium from cobalt. It is necessary to operate upon a very acid liquid, so as to produce a sufficient quantity of ammonium chloride, taking care to boil previously, so as to destroy the per-salts of cobalt. The ammonia is not added until after the liquid has begun to boil. The purpureo-cobaltic salts which are sometimes formed in small quantity, are dissolved and carried away in the washing waters. The gallium oxide thus obtained retains almost always traces of cobalt, which are eliminated on repeating the operation.

Excellent results are obtained either by means of cupric hydrate or of metallic copper and cuprous oxide. Sensible traces of cobalt, however, remain in the first copper precipitates; but they are easily removed by one, or at most, two repetitions.

Separation from Nickel.—Nickel oxide precipitated by an excess of boiling potassa retains gallium more energetically than does cobalt oxide. With a liquid containing 0.005 grm. gallium and 2 to 3 grms. nickel oxide, a very notable proportion of the gallium is found in the precipitate after the seventh treatment with potassa. This procedure is consequently applicable only in case of a small quantity of nickel mixed with much gallium. The galliferous nickel oxide is then analysed by one of the other procedures.

If we have mixtures containing little gallium and a large

mass of protoxides, such as those of cobalt, nickel, manganese, zinc, &c., it is almost always very advantageous to begin by precipitating at a boil all the gallium sesquioxide by means of an alkali, along with a small fraction of the protoxides. The detection of the gallium becomes then easier, since it bears upon a small bulk of matter. The action of calcium and barium carbonates in the cold, as well as that of calcium carbonate in heat after sulphurous reduction, require the same remarks as in case of the separation from cobalt. The author has likewise found that a little more nickel oxide is rendered insoluble with calcium carbonate than with barium carbonate.

A good separation is obtained by boiling with ammonia. The original hydrochloric solution ought to be very acid. Especially if the nickel is abundant the precipitate contains quantities of it not to be neglected. It is removed by repeating the same process once or twice. Cupric hydrate, as well as metallic copper and cuprous oxide, are excellent reagents to employ. The traces of nickel oxide carried down in the precipitates in the first operation are eliminated on repeating it once or twice.

Separation from Thallium.—This separation is not effected satisfactorily by precipitating the alcoholic solution with potassium iodide; thallium remains in the filtrate and sensible traces of gallium in the deposit. It is not more advantageous to reduce the thallium to the metallic state by means of a sheet of zinc. There are thus introduced into the analysis the impurities so frequently contained in zinc, and the thallium carries down gallium, unless the liquid is kept sufficiently acid, but then the precipitation of the thallium is incomplete. The eight following procedures may be recommended, though in different degrees:—

1. Boiling after supersaturation with ammonia gives good results with thallium sulphate, chloride, or nitrate, if slightly acid. The salts must be previously reduced to the lowest stage of oxidation by the addition of a few drops of a solution of sulphurous acid. If slight traces of thallium remain in the precipitate they are entirely eliminated by repeating the boiling with ammonia; the gallium oxide obtained then gives no spectroscopic indication of thallium.

- 2 and 3. Calcium and barium carbonates precipitate gallium in the cold without rendering the thallium insoluble beyond slight traces, which disappear entirely during the operations for removing the lime or baryta. Before adding the carbonates the liquid is reduced by means of sulphurous acid.

4. Calcium carbonate may be used in heat after reduction by means of sulphuric acid. There are sensible traces of thallium in the precipitate, but they are subsequently eliminated along with the lime.

- 5 and 6. Cupric hydrate, as also metallic copper and cuprous oxide, are the best reagents, for the gallium is totally precipitated without carrying down a trace of thallium. If cupric hydrate is employed, the thallium salts must previously be reduced to the lowest stage of oxidation by means of sulphurous acid.

7. If the quantity of thallium is not too considerable, so that its chloride remains dissolved, gallium may be precipitated by potassium ferrocyanide in a very acid solution and at a temperature of 70°. Traces of thallium contaminate the deposit, which is re-dissolved in a small excess of potassa; there are added to the liquid a few drops of ammonium hydrosulphate recently prepared, and the whole is filtered to separate thallium sulphide. The clear solution is evaporated to a small bulk, supersaturated with a large excess of hydrochloric acid, and mixed with a little ferrocyanide. The slight traces of gallium carried down by the small quantity of thallium sulphide may generally be neglected. If needful they may be separated by known methods.

8. Thallium may be thrown down by platinum chloride from an alcoholic solution, acidified with hydrochloric acid. A prolonged current of sulphuretted hydrogen removes the platinum contained in the liquid, from which is

afterwards obtained gallium containing merely traces of thallium. The chloro-platinate, suspended in water acidified with hydrochloric acid, is treated with hydrogen sulphide, which renders the platinum insoluble. The salt of thallium obtained does not contain sensible traces of gallium.—*Comptes Rendus*.

ON CERTAIN SUBSTANCES OBTAINED FROM TURMERIC.

I.—CURCUMIN.*

By C. LORING JACKSON and A. E. MENKE.

(Concluded from p. 62.)

Properties of Curcumin.

Curcumin crystallises from alcohol in stout needles, which under the microscope appear as well-formed prisms with square ends, or spindle-shaped crystals, often arranged in radiating groups; in colour it is orange to yellow, according to the size of the crystals, with a beautiful blue reflex; its solution in ether exhibits a very strong green fluorescence; when pure it has no odour; it melts at 178° , apparently with decomposition.† It is nearly insoluble in water, somewhat soluble in cold, more readily in hot alcohol and methyl alcohol, more soluble in glacial acetic acid than in alcohol, less so in ether, very slightly soluble in benzol‡ and carbonic disulphide, and essentially insoluble in ligroine. Strong sulphuric acid dissolves it with a fine reddish purple colour, which changes to black from charring after some time; strong hydrochloric acid produces the same effect, but with more difficulty. It is readily soluble in alkalis and alkaline carbonates, and is even dissolved to a slight extent when boiled with precipitated calcic carbonate and water. The solution in ammoniac hydrate loses ammonia when boiled, and deposits unaltered curcumin. A solution of baric hydrate converts it into a blackish red powder, but lime-water gives a red solution like that obtained from calcic carbonate. It is not affected by acid sodic sulphite.

Salts of Curcumin.

In taking up the study of this subject we were at first attracted to the lead salt by the analyses and descriptions of Ivanow-Gajewsky and Daube; but, after several experiments, we decided that it was too indefinite a substance to throw much light upon the nature of curcumin, and accordingly turned our attention to the potassium salts, which at first did not seem promising, but on proper treatment have yielded satisfactory results. Before describing these, however, we will say, that there seem to be at least two lead salts, as we have obtained a dark claret precipitate and also a flame-coloured one. The most promising method of preparation seemed to be boiling curcumin with precipitated calcic carbonate and water, and adding plumbic acetate to the filtrate; in this way the flame-coloured salt was obtained.

We have succeeded in obtaining two potassium salts, containing one and two atoms of potassium respectively.

Dipotassic Salt of Curcumin, $K_2C_{14}H_{12}O_4$.

This was made by adding a large excess of a strong alcoholic solution of potassic hydrate to a hot saturated solution of curcumin in alcohol; if the solutions are strong enough, flame-coloured crystals of the salt are deposited on cooling; if this is not the case, it can be precipitated by addition of ether. If an insufficient amount of potassic hydrate is used, a dark red solution of the mono-potassic salt is formed, which becomes lighter on the addition of more potassic hydrate as the second

atom of potassium is taken up. The salt was crystallised from boiling alcohol, to which a few drops of ether had been added, washed with a mixture of alcohol and ether, then with ether alone, pressed on filter-paper, and dried as rapidly as possible in a steam-drying closet containing some potassic hydrate.

0.7168 grm. of the salt gave, heated with sulphuric acid, 0.3824 grm. of K_2SO_4 .

0.2675 grm. gave 0.1459 grm. of K_2SO_4 .

	Calculated for $C_{14}H_{12}K_2O_4$.	Found.
Potassium ..	24.27	23.95 24.48

If curcumin had the formula $C_{16}H_{16}O_4$ the dipotassic salt would contain—

Potassium ..	22.46
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The salt consists, when first formed, of flame-coloured needles in globular radiating groups, but becomes deep claret on drying. It is freely soluble in water, not quite so soluble in alcohol, and essentially insoluble in ether; the alcoholic solution takes on a magenta colour when exposed to the air, and the salt seems to absorb carbonic dioxide readily, although the change of colour was more probably due to oxidation.

Mono-potassic Salt of Curcumin, $KC_{14}H_{13}O_4$.

If an excess of potassic carbonate is added to a hot solution of curcumin in absolute alcohol, there is a violent effervescence, and the liquid turns deep blood-red. After slight concentration the excess of potassic carbonate was removed by filtration, the salt precipitated with ether, and purified by washing with ether. An attempt to crystallise it from a mixture of alcohol and ether gave no satisfactory result. Pressed between filter-paper, and then dried at 100° , it gave the following results:—

I. 0.4808 grm. of the salt gave after ignition with sulphuric acid 0.1540 grm. of K_2SO_4 .

II. 0.5381 grm. of salt gave 0.1680 grm. of K_2SO_4 .

	Calculated for $KC_{14}H_{13}O_4$.	I.	Found.	II.
Potassium ..	13.76	14.36		14.02

$KC_{16}H_{15}O_4$ contains 12.60 per cent of potassium.

This salt is precipitated in crimson black flocks, which dry to a mass having the green colour and lustre of rosanilin, although the shade is somewhat blacker. It is very easily soluble in water and alcohol, giving blood-red solutions, but insoluble in ether, and does not seem to be altered by exposure to the air. It can also be made by the action of an excess of curcumin on the dipotassic salt, or by adding potassic hydrate not in excess to curcumin suspended in alcohol. It is very much more soluble than the dipotassic salt.

Curcumin forms also a flame-coloured calcium salt, slightly soluble in water, which can be made by adding calcic chloride to a solution of the mono-potassic salt. The same salt is formed in small quantity when calcic carbonate is boiled with curcumin and water or alcohol, carbonic dioxide being set free.

The zincic salt seems to be soluble, the baric salt insoluble,* while the silver salt is probably very unstable, as curcumin is decomposed when boiled for more than a minute with argentic nitrate and alcohol.

The fact that only one atom of the hydrogen contained in curcumin can be replaced by the potassium of potassic carbonate would point to the existence of one, and only one, carboxyl group in its molecule; the presence of this group is confirmed further by the power of decomposing calcic carbonate possessed by curcumin.† The replacement of a second atom of hydrogen when curcumin is

* From the *Proceedings of the American Academy*. Communicated by the Authors.

† Daube found 164° ; Gajewsky, 172° or 140° .

‡ Compare Daube, *Ber. Deutsch. Chem. Ges.*, 3, 609.

* As our work on the potassium salts had achieved the end for which we undertook the study of the salts of curcumin, we thought it not worth while to purify any of the other salts for analysis.

† Some experiments on the action of phosphorus trichloride upon mono-ethyl-curcumin confirmed the presence of a carboxyl group, so far as they went, but the product was too ill-defined to repay a thorough study.

treated with potassic hydrate in excess indicates the existence of a hydroxyl group, probably a phenol hydroxyl, and it would seem, therefore, that curcumin is a diatomic mono-basic acid.

Esters of Curcumin.

Although the analyses of the potassium salts had agreed with the formula of curcumin derived from the analysis of the original substance, it seemed desirable to confirm this formula still further by the study of some derivative of curcumin more stable and easily handled than the salts; we accordingly took up the investigation of the esters, but found that the ethyl-ester made by the action of ethyl-iodide on the dipotassic salt, was a disagreeable brownish black tarry substance, that could not be obtained in a crystalline condition. We therefore abandoned the study of this substance and turned our attention to the mono-para-brom-benzyl-ester, which we preferred to the benzyl-ester, in the first place because of the great tendency of the para-brom-benzyl compounds to crystallise, and secondly, since the presence of bromine increased the difference between the percentages of carbon in the two formulæ by more than five-tenths of 1 per cent, and also gave a third element whose quantity could be determined.

Mono-para-brom-benzyl-ester of Curcumin, $C_{14}H_{13}(C_7H_4Br)O_4$.

To an alcoholic solution of the mono-potassic salt of curcumin an excess of para-brom-benzyl-bromide was added, and the mixture allowed to stand for several days, when it was found that pale yellow crystals mixed with potassic bromide had been deposited; the dark-coloured liquid was poured off, and the solid residue freed from para-brom-benzyl bromide by repeated treatment with hot ligroine, and from curcumin by boiling with successive portions of aqueous potassic carbonate, until it ceased to give a red solution. The essentially pure ester thus obtained was boiled several times with alcohol, which dissolved a small portion of it, while the residue melted to a reddish black tar; upon dissolving this in glacial acetic acid and precipitating with water, yellowish flocks were thrown down, the melting-point of which was compared with that of the similarly-coloured indistinct crystals obtained by cooling the alcoholic extract. As both these substances melted, or, more accurately, drew together, at the same temperature, the ester seemed to be essentially pure, and after drying at 50° to 60° was analysed.

I. 0.1796 grm. of substance gave 0.3980 grm. of CO_2 and 0.0817 grm. of H_2O .

II. 0.2506 grm. of substance gave according to Carius 0.1156 grm. of AgBr.

	Found.	Calculated for $C_{14}H_{13}(C_7H_4Br)O_4$.	$C_{14}H_{13}(C_7H_5Br)O_4$.
Carbon ..	60.43	60.72	62.58
Hydrogen ..	5.05	4.57	4.76
Bromine ..	19.63	19.26	18.14

From these results there can be no doubt that $C_{14}H_{14}O_4$ is the true formula of curcumin.

The ester consists of indistinct crystals, grouped in forms like cauliflowers, of a much paler yellow colour than curcumin; it melts at 76° to 78°, beginning to draw together at 76°, and becoming thoroughly liquid at 78°; we have not succeeded in obtaining it with a perfectly sharp melting-point. It is more soluble in glacial acetic acid than in alcohol; nevertheless the latter is to be preferred as a solvent for obtaining crystals, since the substance is apt to separate from the hot glacial acetic acid in a fused tarry condition. It is readily soluble in ether and benzol, but does not crystallise well from these solvents; slightly soluble in carbonic disulphide; essentially insoluble in ligroine; not attacked by a solution of potassic carbonate, but soluble in potassic hydrate, although without the red colour characteristic of curcumin.

As the analysis of this ester establishes our formula, we have not continued the study of the esters.

Oxidation of Curcumin.

Our experiments on this subject can be divided into two classes, those in which we made a complete oxidation of the substance, and those in which a partial oxidation was obtained by using an insufficient amount of the oxidising agent, or one less energetic.

Complete Oxidation.—As Ivanow-Gajewsky states that he obtained terephthalic acid by the action of potassic dichromate and sulphuric acid on curcumin, we turned our attention first to this experiment. Unfortunately only an abstract of his paper is accessible to us, so that we could not find the exact conditions of his oxidation; we have therefore varied the conditions in several ways, but always with the same result. It will be sufficient to describe a single experiment. Half a grm. of curcumin was mixed with sulphuric acid previously diluted with its own volume of water, and solid potassic dichromate added; the action was extremely violent, accompanied by great evolution of heat and strong effervescence; the gas given off was carbonic dioxide. At the end of the process there was no insoluble substance in the liquid, which was therefore distilled until it was reduced to a small volume. The strongly acid distillate, treated with argentic oxide, after filtering and concentration, deposited long flattened needles, which looked exactly like argentic acetate, and were proved to consist of this substance by the following silver determination:—

0.1812 grm. of salt dried at 100° gave 0.1559 grm. of AgCl.

	Calculated for $Ag_2C_8H_4O_6$.	Found.
Silver	64.68	64.76

There was no other volatile acid in the distillate, and no organic matter could be found in the residue from the distillation. If the action was moderated by using more dilute sulphuric acid, the phenomena were the same, except that it was necessary to start the reaction by the aid of heat. In none of the products of the oxidation of curcumin with potassic dichromate could any terephthalic acid be found; they consisted only of acetic acid and carbonic dioxide.

If curcumin is dropped into fuming nitric acid it dissolves with a hissing noise and formation of nitrous fumes and hydrocyanic acid. The red liquid thus obtained gave no precipitate with water; on evaporation it deposited brownish crystals, principally oxalic acid, but it was not further examined. In this respect we confirm the results of Daube, who also obtained oxalic acid from curcumin and nitric acid.

Incomplete Oxidation.—When curcumin was dissolved in aqueous potassic hydrate, a solution of potassic permanganate added, not in excess, and after the oxidation had ceased, the liquid acidified with sulphuric acid, a strong smell of vanilla was observed. The liquid was accordingly filtered, and the precipitate thoroughly washed with boiling water, the filtrate and wash-water extracted with ether, and the extract treated with acid sodic sulphite, as directed by Tiemann and Haarmann.* The product was an oil, having a strong smell of vanilla and gradually solidifying in circular groups of radiating needles; the amount, however, was extremely small, and none of this product was obtained with an excess of potassic permanganate or when the quantity of curcumin was much more than half a grm. The same substance was obtained with various weak oxidising agents, such as bleaching-powder and water, potassic ferricyanide with potassic hydrate, and even the action of atmospheric oxygen on curcumin dissolved in potassic hydrate. Of these the mixture of potassic hydrate and potassic ferricyanide gave the best yield, but even this was extremely small—in fact, after uniting the product from all the oxidations made by us, in which over 8 grms. of curcumin were used, the

* Ber. Deutsch. Chem. Ges., 8, 1125.

quantity was not enough for complete purification. By sublimation, however, and subsequent crystallisation from boiling water, it was obtained in white needles resembling in appearance and odour the vanillin from the vanilla-bean, and melting at 79°. Vanillin melts at 80° to 81°.

In addition to the vanillin there were formed carbonic dioxide, a black amorphous substance with feebly acid properties, perhaps the aldehyd resin of vanillin, as it appeared in largest quantity when no vanillin was obtained, and an acid volatile with steam. We have not as yet made any complete study of these secondary products, because the properties of the humus-like substance are far from inviting, and the amount of the volatile acid is so minute that its isolation in quantity sufficient for analysis would be extremely laborious. We shall, however, return to these substance if we fail in finding easier methods for studying the nature of the side-chain.

As the small yield of vanillin was undoubtedly due to the presence of the phenol hydroxyl, which offered a point of attack for the oxidising mixture, we next tried to increase our yield by replacing the hydroxyl hydrogen with some radical which would protect it from oxidation, and in this way not only prove that the substance was really vanillin, but also that it was one of the principal products of the oxidation. For this purpose we first tried to make acetyl-curcumin by treating curcumin with acetyl-chloride; this gave a deep bluish green liquid, which on standing turned brown, and then yielded on addition of water a yellowish precipitate which could not be obtained in crystals, its solutions forming on evaporation a dark-coloured varnish. With acetic anhydride no better results were obtained, and as there seemed no prospect of getting a good analysis of the substance, it was at once oxidised with potassic permanganate. The result was not essentially better than that obtained with pure curcumin, and we accordingly turned our attention to the oxidation of diethyl-curcumin, which was made by boiling the dipotassic salt with absolute alcohol and a slight excess of ethyl-iodide for six hours in a flask with a return cooler. On distilling off part of the alcohol and allowing the rest to evaporate spontaneously, the compound is left as a most uninviting brownish black tar, which when heated with sodic hydrate dissolves with a dark red colour resembling that of the alkaline solution of curcumin. Upon treating this solution with potassic permanganate until it was decolourised, filtering from manganic hydrate, and acidifying with sulphuric acid, a yellowish precipitate was obtained, which after two crystallisations from boiling water with bone-black melted at 195°, the melting-point given by Wassermann* for ethyl-vanillic acid (Tiemann† gives 193° to 194°).

The nature of the substance was still further confirmed by the following combustion:

0.1216 grm. of substance gave 0.2714 grm. of CO₂ and 0.0707 grm. of H₂O.

	Calculated for C ₁₀ H ₁₂ O ₄ .	Found.
Carbon	61.22	60.87
Hydrogen	6.12	6.46

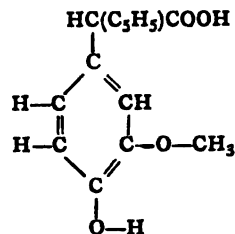
There can be no doubt, therefore, that the substance is ethyl-vanillic acid, and it was formed in such quantity that it must be considered one of the principal products of the reaction. If the potassic permanganate was not added in excess, and the liquid extracted with ether, crystals of ethyl-vanillin were obtained, which on sublimation formed an oil solidifying after a short time in large twinned crystals like those of cassiterite, and having a smell similar to that of vanillin, but not identical with it.

Summary of Results.

The formula of curcumin is C₁₄H₁₄O₄, as proved by analyses of curcumin itself, of its potassium salts, and its para-brom-benzyl-ester.

* *Annalen der Chemie*, 179, 366.
† *Ber. Deut. Chem. Ges.*, 6, 1127.

It is a phenol-carboxylic acid, as shown by the study of its salts. The presence of carboxyl is indicated by its power of driving carbonic acid out of potassic and calcic carbonates, and by the decomposition of its diethyl-ester on boiling with potassic hydrate. It contains the vanillin group, and therefore its formula, as far as we have determined it, is:—



We are at present engaged in the study of the group C₃H₅, and propose to extend our investigations to rosocyanin and the turmeric oil.

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

(Continued from p. 66.)

IN reference to the results obtained by the albumenoid-ammonia process, little more is presented than has already been fully discussed in an earlier part of the general report. The total loss of the amine bases by volatilisation during the first distillation (with sodium carbonate) results practically, as these bases do not produce the ammonia colour with the Nessler reagent, in their nitrogen escaping recognition under the head of either "free" or "albumenoid" ammonia. Here we have a proof that some, at least, of the nitrogenous products of putrefaction are not detected or determined by this process as usually conducted.† There is no discrepancy between the results as to these bases here noticed and that recorded for a triethylamine salt in Table VII. of the general report; in this last-mentioned case the salt was in contact with alkaline permanganate from the commencement of the distillation.

The results in this Class IX. by the permanganate process have mainly the same sort of interest. It has, of course, long been known that, in the words of Tidy,‡ "there are many substances (most of which are crystalline) that are altogether unacted upon, or very slowly acted upon, by the oxygen of permanganate"; but it has been distinctly claimed for this process§ by the same chemist that "it undoubtedly furnishes us with exact information as to the relative quantities of putrescent and easily oxidisable matter, and of non-putrescent or less easily oxidisable matters, present in the water. The former (viz., the putrescent organic matters) it indicates quantitatively with great accuracy; the latter (viz., the non-putrescent matters) are scarcely capable of the same exact estimation as the former, for they are bodies for the most part of difficult oxidation." Now here we have some of the definite substances which are actually known to occur among the constituents of putrescent albumenoid matter, and it needs but a glance at the table to see how limited is their oxidation by the cold acid permanganate, and yet how

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† Wanklyn has excepted nitro-compounds and (erroneously) urea, but clearly implies that these are the only exceptions; that the nitro-compounds are without practical importance, and that urea is specially provided for.—"Water Analysis," London 1879; 189.

‡ *Four. Chem. Soc. (Lond.)*, Jan., 1879; 78.

§ *Loc. cit.*, 60.

considerable are the differences in behaviour of these few substances selected mainly on the same general principle.

Of course it is not assumed that the figures in Table XIV. really represent either the range of absolute error, or the average amount of absolute error, of the different processes as applied to the doubtless very various forms of organic matter liable to occur in natural waters. These figures do, however, illustrate the existence of sources of absolute error, and by examples taken from the very class of substances which it has been most commonly believed important to detect and determine in water analysis.

Effect on the results by the different processes of varying the extent of dilution of the same organic substances in water.—The evidence in regard to this point is graphically presented in Tables XV., XVI., and XVII.

(These tables will appear with the general report.)

In studying these tables, indications of definite effects on the results of the various processes arising from the degree of dilution of the liquids examined soon became apparent, but seemed to be subject to much irregularity. Such irregularity, however, is much reduced by a careful consideration of all the circumstances affecting individual cases. Thus, some of the numerical results of analysis ought to be omitted from consideration as vitiated by known errors, as in the case of albumenoid ammonia determinations in obtaining which the whole of the alkaline permanganate was reduced, or an obviously considerable part of the ammonia was still coming off when the process had to be stopped. In other cases the value of the results is rendered doubtful by the solution examined having been excessively dilute or excessively strong; the relatively greater analytical errors for the former, and for the latter the errors of measurement of very small quantities of the liquid itself and greater uncertainty as to its uniformity when turbid, tend to make the figures obtained less trustworthy than when intermediate degrees of concentration were involved; Nos. 110 to 118 inclusive represent the former source of abnormal results, such waters as No. 100 the latter. Again, the three solutions containing each form of polluting material in different degrees of dilution were, as has been explained, necessarily examined on different days, and evidence of changes going on in the meantime are to be found in the relative amounts of free and albumenoid ammonia, the character of the dissolved gases, &c.) see for the latter Nos. 83, 84, 85; hence the order in which the three solutions of each group were examined has to be taken into account. Further, the results of one of these tables have often to be considered in their bearing on those of the others, as, for instance, the free ammonia determinations as affecting the value of the figures for organic nitrogen. And, lastly, after having observed the general drift of the errors indicated, we can see in the varying balance of errors of opposite effect an explanation of many apparently exceptional figures.

The general results of such detailed study of individual cases agree with those obtained by a simple calculation of averages, omitting from the calculation such figures as on sound grounds of general principle are to be regarded as vitiated for the purpose of this discussion. In the following table the solutions of the seven pure chemicals (Nos. 141 to 161) have been left out on account of the abnormal relations of these (which have been separately discussed) to some of the processes. For the combustion process, two other substances, represented by the dilutions Nos. 101 to 103, and 122 to 124, are omitted, because in the former of these the figures for organic carbon are known to be of very little value, and those for organic nitrogen are entirely valueless in consequence of the uncertain determinations of free ammonia present in large quantity (which had to be subtracted from the gross results of analysis), while in the latter the very large amount of the free ammonia correction makes the results doubtful. For the albumenoid ammonia process, those determinations of free ammonia originally marked by Dr. Smart as uncertain (by a ?) have been omitted, and those determinations of albumenoid ammonia in making which

the regular charge of alkaline permanganate was entirely reduced, requiring an additional charge to be afterwards added, or dilution to be resorted to. For the Kubel form of the permanganate process one or two cases have been omitted, in which the permanganate was entirely reduced, making the result valueless save as an approximation. Rejecting these obviously worthless data, the averages from all others are given in Table XVIII.

TABLE XVIII.

Average Results obtained for Different Dilutions of same Solution of Organic Matter.

	One-fifth per cent strength.		One p.c. strength.	Five per cent strength.	
	Calc.	Obtnd.	Assumd.	Calc.	Obtnd.
Combustion process—					
Organic carbon	20.0	17.5	100.0	500.0	549.8
Organic nitrogen	20.0	25.2	100.0	500.0	372.2
Albumenoid ammonia process—					
Free ammonia	20.0	39.9	100.0	500.0	445.3
Albumenoid am.	20.0	27.2	100.0	500.0	257.9
Permanganate process—					
Tidy method—					
Oxygen consmd					
in 1 hour ..	20.0	19.7	100.0	500.0	475.0
Oxygen consmd					
in 3 hours ..	20.0	20.0	100.0	500.0	468.9
Kubel method—					
Oxygen consmd	20.0	19.9	100.0	500.0	475.9

As regards the combustion process, we find distinct confirmation of the existence of the two forms of constant error which have been pointed out as affecting the evaporation.* The weaker the solution—or, in other words, the larger the quantity of water to be evaporated for a given amount of organic matter—the less is the amount of organic carbon obtained, indicating relatively greater loss of this element. On the contrary, the weaker the solution or the greater the quantity of water to be evaporated, the larger is the figure for organic nitrogen, indicating relatively greater gain of this element from the atmosphere, and probably in some cases less dissociation of ammoniacal salts, when the amount of free ammonia found is considerable. If the usual interpretation of Frankland C : N ratio be applied, the curious and important result of these sources of error, affecting the two elements in opposite directions, follows, that the more dilute an organically polluted water is the more animal-like in origin will its polluting material seem to be, while the stronger it is the greater will be the tendency to refer the contamination to a vegetable source. This distortion of the conclusions to be drawn from an examination by the combustion process is manifestly in the opposite direction to that commonly assumed to be safe.

In reference to the albumenoid-ammonia process, the weaker the solutions are the higher are the results obtained, both for free and albumenoid ammonia,† the influence common to both being probably that of imperfect condensation in the distillation, having a less effect as the quantity of ammonia is smaller. As for the albumenoid ammonia, the lower results obtained from the stronger solutions may be partly due to the smaller proportion borne by the fixed charge of alkaline permanganate to the quantity of organic matter to be acted on. The great irregularity in individual analyses is strongly indicative of a varying balance of errors from different sources. It will be observed that the discrepancy between the calculated

* Compare the results observed by Mills (*Jour. Chem. Soc., Lond.*, Feb., 1878; 60) in using evaporating dishes of different diameters. The larger dish gave a rather lower result for carbon, and higher for nitrogen.

† This agrees with Dr. Smart's single experiment on Washington sewage in its original form and diluted. See "remarks" on No. 116 in Table X. of General Report.

figures and those of experiment is greatest for free ammonia in the case of the weakest dilution, while the reverse is true for albumenoid ammonia.

The results of the permanganate process are shown to be much less influenced by varying dilution within the limits involved in these experiments than those of the other processes. In the case of the solutions of greatest strength somewhat smaller figures are obtained for the oxygen consumed than calculation calls for.* This is probably due to the fact that for the weaker waters the ordinary fixed charge of permanganate added at the first leaves at the close of the process a relatively larger excess than is present when successive additions of the reagent have been made to a water strong enough to reduce the first charge completely.

We must not confound the effect of varying the amount of organic matter in relation to the permanganate by which it is to be oxidised with that of varying greatly, but to the same extent, the degree of dilution of both organic matter and permanganate at the same time. Dr. Tanner's experiments showed that under the latter head a solution of even potassium nitrite might be made so dilute that its action on a correspondingly small quantity of permanganate was rendered very slow.

It may, perhaps, be said in reference to all these experiments on varied dilutions of the same materials, that the several processes under examination are intended for use on water of approximately suitable character for drinking, not on comparatively strong solutions of organic matter, such as many of those I have employed, but the answer to this objection is that these liquids were taken in order to *exaggerate*, and hence bring to light any defects inherent in the several processes, so far as such depend upon the simple condition of the amount of polluting material in proportion to that of pure water.

SPECIAL CONCLUSIONS AS TO THE COMBUSTION PROCESS.

These may be briefly stated as follows:—

1. The combustion itself, carried out according to the directions of Frankland, is a process of great delicacy, and quite satisfactory in its details with proper precautions and in trained hands. There seems to be no advantage in employing any of the various modified ways of determining the gaseous products of combustion which have been proposed instead of gaseous volumetric analysis with the aid of the Sprengel vacuum.

2. The Frankland process is quite within the reach of the manipulative skill of any fairly-trained chemist, but it requires practice, and probably pretty constant practice. It cannot be taken up off-hand, and even tolerable results obtained at once. From the hands of a person without proper laboratory training its results are utterly valueless. It is hence better adapted to regular use in the examination of many samples of water in a large public laboratory than to occasional use by a private individual in now and then examining a single water.

3. The defective point in the process is the failure of the evaporation to leave a residue representing the original organic matter of the water. This, which has been hitherto more or less suspected, has been established as a fact by the investigation now reported on. The process being conducted according to the directions of its authors, there are two constantly present errors, varying, but usually important in amount, namely, loss of carbon,† and gain of nitrogen from the atmosphere, the latter probably partly balanced by loss of that originally present in the water. These errors are relatively greatest when the quantity of organic matter in the water is small.

* Some indications of a like result may be noticed in a few experiments of Tidy (*Jour. Chem. Soc., Lond.*, Jan., 1879; 80, 81) though the variation in strength of his solutions was not so great, and he himself draws the conclusion that the consumption of oxygen was proportional to the strength.

† In connection with this a number of Dr. Smart's experiments are noteworthy, in which the distillate for free ammonia furnished evidence, by its haziness and greenish colour, distinct from that which the Neseler reagent should have yielded, that volatile organic matter was present.

4. These errors, affecting unequally the carbon and nitrogen, are liable to alter the statement of C : N ratio,* and hence to distort the sanitary conclusions usually drawn therefrom.

5. The result for organic nitrogen, as obtained by the combustion process, is also affected indirectly by the errors connected with the determination of the ammonia ("free ammonia"), as the nitrogen belonging to this has to be subtracted from the gross result. The existence of such errors, as from imperfect condensation of the ammonia, progressive decomposition of urea and other amides, &c., has been pointed out in previous parts of this report, and will be referred to in the conclusions as to the albumenoid ammonia process.

6. There is a further indirectly operative cause of error as to the nitrogen, arising from the varying loss of ammonia by dissociation of its salts during the evaporation of the water, Frankland recognises the necessity of a correction for this, which correction he makes depend upon the amount of ammoniacal salts present, but it is almost certain that the time occupied in the evaporation will also influence the extent of loss by dissociation. Error from this source will in most cases be very small, but may affect to a not unimportant extent the result for organic nitrogen.†

7. The combustion process involves special difficulties in the presence of nitrates, for which difficulties no completely satisfactory remedy is as yet proved to have been found. M. W. Williams's mode of applying the copper-zinc couple for this purpose is deserving of more precise quantitative examination than it has yet received. The simultaneous presence in a polluted water of urea with nitrites and nitrates presents a case of peculiar difficulty involving several sources of error.

8. The formation of sulphuric acid during the evaporation of the water with sulphurous acid seems to be of more frequent occurrence than has hitherto been recognised. Mr. Noyes seems to think that to this source—small amounts of cupric sulphate being formed on mixture of the residue with cupric oxide—may perhaps be attributed the occasional presence, as noticed by Frankland, of traces of free oxygen among the gaseous products of combustion. This occurrence of sulphuric acid in the water residue, even in minute amount, is undoubtedly much to be deprecated, though its effect, at any rate on the carbon determinations, has not seemed to be as great as might have been expected.

9. The combustion process in its present form cannot be considered as "determining" the carbon and nitrogen of the organic matter in water in a sense to justify the claim of "absolute" value for its results which has been denied to those of all other methods. It is but a method of approximation, involving sundry errors, and in part a balance of errors.

10. There is, however, good ground for believing that in many, perhaps most, cases its results for organic carbon may, with proper precautions, be made more valuable than the indications of the permanganate process, and its results for organic nitrogen in like manner more valuable than the indications of the albumenoid-ammonia process.

SPECIAL CONCLUSIONS AS TO THE ALBUMENOID-AMMONIA PROCESS.

These may be briefly summed up as follows:—

1. In the determination of both "free" and "albumenoid" ammonia there is a loss, which may be quite considerable, resulting from imperfect condensation of the ammonia during distillation. This loss varies in amount with the precise conditions under which the distillation is

* In Prof. W. R. Nichols's "Report on the Boston Water Supply (Fourth Annual Report of Boston Water Board, 1880)," variations of the C : N ratio, extending from a given value to one, three, or three and a half times as great are observable for the Cochituate water within a few weeks, and still greater variations for the Mystic water.

† Examples are furnished by Frankland of analyses in which the ammonia correction is very large in comparison with the organic nitrogen.

conducted, especially with the efficiency of the cooling apparatus and the time occupied in the process.

2. In the case of waters containing urea, and also other amidated bodies, such as the leusine and tyrosine occurring among the products of putrefactive decay, some ammonia is so easily formed from these substances by boiling with sodium carbonate, or even without this addition, that it is impossible to distinguish sharply between pre-existing "free" ammonia (of ammoniacal salts) and that formed by the action of alkaline permanganate, the so-called "albumenoid" ammonia. This source of error as to the free ammonia reacts, as has been noticed above, upon the result for organic nitrogen by the combustion process.

3. There is no satisfactory evidence in favour of Wanklyn's view that, in distilling with alkaline permanganate, definite and simple fractions of the nitrogen of organic matter are given off as "albumenoid" ammonia. Such results may be varied at pleasure for most, if not for all, substances, by slight modification of the conditions under which the distillation is conducted.

4. If the distillation with alkaline permanganate be carried out as usual, in accordance with Wanklyn's instructions, it frequently happens that the nitrogenous organic matter is so gradually acted upon as to make the ending of the process indefinite; ammonia is still coming off when the distillation has to be stopped in consequence of the contents of the retort being nearly reduced to dryness. In such cases an unknown fraction of the possible amount of albumenoid ammonia fails to be collected, and is but vaguely indicated by the sign + after the figures recorded.

5. There is evidence that in some cases nitrogenous organic matter is volatilised during the distillation for free ammonia, which, if it had been retained, would have yielded up its nitrogen as albumenoid ammonia; not affecting the Nessler reagent; such nitrogenous matter escapes detection under either head.

6. The albumenoid-ammonia process proper, *i.e.*, the distillation with alkaline permanganate and determination of the ammonia evolved, is admittedly simple and easily carried out with very little preparatory training.

7. The value of the results by this process depends more upon watching the *progress* and *rate* of evolution of the ammonia than upon determining its total amount.

8. Taking the results by this process as recorded, we find a good deal of general similarity between the figures for albumenoid ammonia and those for organic nitrogen (by the combustion process), but with frequent discrepancies of varying extent, such as prevent the one being taken as the accurate measure of the other. (See Tables XIX. and XX., further on.)

SPECIAL CONCLUSIONS AS TO THE PERMANGANATE PROCESS.

The chief points worthy of attention are the following:—

1. The results obtained by the Tidy method (using the acidified permanganate at common temperature) and by that of Kubel (operating at the boiling point) differ irregularly from each other, the latter usually giving much higher figures, as was to be expected, but the ratio between the results by the two methods varies much in different cases.

2. On the whole, there seems usually to be a nearer approach to proportionality with the quantities of organic carbon* found by the combustion process on the part of

* This appears to be the proper way of comparing the results of the permanganate with those of the combustion process. The former process is clearly concerned much more with carbon than nitrogen, if oxygen be usually at all consumed by nitrogen. It is not easy to admit the soundness of the logic with which Tidy (*Four. Chem. Soc.*, London, January, 1879, 94-97) points to the concordance of results, by the permanganate and combustion processes, and the disagreement with both these of the results by the albumenoid-ammonia process, and hence apparently infers that the two former are trustworthy, and the last not so. He uses the *sum* of organic carbon and nitrogen to represent the results by the combustion process, and as the carbon forms generally much the larger part of this, he

the results afforded by the Kubel process than on that of the Tidy results, but to this there are some very notable exceptions. (See, on this point, Tables XIX. and XX., further on.)

3. In a good many instances the results obtained by the Kubel method are, contrary to the general rule, lower than those afforded by the Tidy method. This seems to be due, in all probability, to loss of organic matter by volatilisation with the escaping steam from the boiling liquid before time has been afforded for action on the permanganate.* An examination of all the results obtained for Nos. 131, 132, and 133, and several other cases, gives good ground for believing this to be the case. Of course, a similar loss may have occurred in other instances, but not to the extent of reversing the general rule as to the results of the Kubel process being larger than those by the method of Tidy; and this may in part explain the absence of any uniform ratio between the figures yielded by those two modifications of the permanganate process.

4. The results obtainable by the Tidy process are liable to variation with the atmospheric temperature prevailing at the time the process is applied.

5. The amount of oxygen consumed by a specimen of water is probably in all ordinary cases much below that required for complete oxidation of the organic matter present, and does not stand in any fixed ratio thereto; it cannot be taken as a measure either of the organic carbon or of the total organic matter. Nevertheless, a distinct general resemblance may be traced between strongly marked results, high or low, as the case may be, for the consumption of oxygen on the one hand, and organic carbon (by the combustion process) on the other; and closer agreement is observable in regard to waters of generally similar character.†

6. The permanganate process is capable of giving more valuable information in regard to a water by watching the *progress* and *rate* of the oxidation of organic matter present than by any single determination of the absolute amount of oxygen consumed in a given time.

7. For such observation of the progress of oxidation the two determinations prescribed by Tidy, *viz.*, of oxygen consumed in one hour and in three hours, respectively, are not sufficient, nor is the latter period of three hours long enough to indicate the general behaviour of the water with acid permanganate.

(To be continued.)

NOTICES OF BOOKS.

Irenicon, No. 2. *Faith, the Life-root of Science, Philosophy, Ethics, and Religion.* By H. GRIFFITH, F.G.S. London: Elliot Stock.

MUCH of the work before us does not fall within the legitimate purview of the CHEMICAL NEWS. Still we find here no little matter which the physicist and chemist not only may, but should, consider, and to which we accordingly feel free to draw attention. Mr. Griffith's fundamental idea appears plainly in the title he has selected, and will by many be regarded as startling, if not absolutely paradoxical. The life-root of Science, say and think many, is by no means faith, but sight, or rather the direct evidence of our senses in general. We believe, say they, what we see and nothing further. They may

naturally arrive at an agreement with the results of the process mainly depending on the oxidation of carbon, and disagreement with those of the process evolving nitrogen as ammonia.

* It is worthy of remark that the largest number of cases among natural waters of the Kubel process giving a lower result than that by the Tidy process occur among the waters believed to be *dangerous*; *i.e.*, Class II.

† In accordance with the remarks of Frankland: "Water Analysis," p. 35.

figures and those of experiment is greatest for free ammonia in the case of the weakest dilution, while the reverse is true for albumenoid ammonia.

The results of the permanganate process are shown to be much less influenced by varying dilution within the limits involved in these experiments than those of the other processes. In the case of the solutions of greatest strength somewhat smaller figures are obtained for the oxygen consumed than calculation calls for.* This is probably due to the fact that for the weaker waters the ordinary fixed charge of permanganate added at the first leaves at the close of the process a relatively larger excess than is present when successive additions of the reagent have been made to a water strong enough to reduce the first charge completely.

We must not confound the effect of varying the amount of organic matter in relation to the permanganate by which it is to be oxidised with that of varying greatly, but to the same extent, the degree of dilution of both organic matter and permanganate at the same time. Dr. Tanner's experiments showed that under the latter head a solution of even potassium nitrite might be made so dilute that its action on a correspondingly small quantity of permanganate was rendered very slow.

It may, perhaps, be said in reference to all these experiments on varied dilutions of the same materials, that the several processes under examination are intended for use on water of approximately suitable character for drinking, not on comparatively strong solutions of organic matter, such as many of those I have employed, but the answer to this objection is that these liquids were taken in order to *exaggerate*, and hence bring to light any defects inherent in the several processes, so far as such depend upon the simple condition of the amount of polluting material in proportion to that of pure water.

SPECIAL CONCLUSIONS AS TO THE COMBUSTION PROCESS.

These may be briefly stated as follows:—

1. The combustion itself, carried out according to the directions of Frankland, is a process of great delicacy, and quite satisfactory in its details with proper precautions and in trained hands. There seems to be no advantage in employing any of the various modified ways of determining the gaseous products of combustion which have been proposed instead of gaseous volumetric analysis with the aid of the Sprengel vacuum.
2. The Frankland process is quite within the reach of the manipulative skill of any fairly-trained chemist, but it requires practice, and probably pretty constant practice. It cannot be taken up off-hand, and even tolerable results obtained at once. From the hands of a person without proper laboratory training its results are utterly valueless. It is hence better adapted to regular use in the examination of many samples of water in a large public laboratory than to occasional use by a private individual in now and then examining a single water.
3. The defective point in the process is the failure of the evaporation to leave a residue representing the original organic matter of the water. This, which has been hitherto more or less suspected, has been established as a fact by the investigation now reported on. The process being conducted according to the directions of its authors, there are two constantly present errors, varying, but usually important in amount, namely, loss of carbon,† and gain of nitrogen from the atmosphere, the latter probably partly balanced by loss of that originally present in the water. These errors are relatively greatest when the quantity of organic matter in the water is small.

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4. These errors, affecting unequally the carbon and nitrogen, are liable to alter the statement of C:N ratio, and hence to distort the sanitary conclusions usually drawn therefrom.

5. The result for organic nitrogen, as obtained by the combustion process, is also affected indirectly by the errors connected with the determination of the ammonia ("free ammonia"), as the nitrogen belonging to this has to be subtracted from the gross result. The existence of such errors, as from imperfect condensation of the ammonia, progressive decomposition of urea and other amides, &c., has been pointed out in previous parts of this report, and will be referred to in the conclusions as to the albumenoid-ammonia process.

6. There is a further indirectly operative cause of error as to the nitrogen, arising from the varying loss of ammonia by dissociation of its salts during the evaporation of the water. Frankland recognises the necessity of a correction for this, which correction he makes depend upon the amount of ammoniacal salts present, but it is almost certain that the time occupied in the evaporation will also influence the extent of loss by dissociation. Error from this source will in most cases be very small, but may affect to a not unimportant extent the result for organic nitrogen.†

7. The combustion process involves special difficulties in the presence of nitrates, for which difficulties no completely satisfactory remedy is as yet proved to have been found. M. W. Williams's mode of applying the copper-zinc couple for this purpose is deserving of more precise quantitative examination than it has yet received. The simultaneous presence in a polluted water of urea with nitrites and nitrates presents a case of peculiar difficulty involving several sources of error.

8. The formation of sulphuric acid during the evaporation of the water with sulphurous acid seems to be of more frequent occurrence than has hitherto been recognised. Mr. Noyes seems to think that to this source—small amounts of cupric sulphate being formed on mixture of the residue with cupric oxide—may perhaps be attributed the occasional presence, as noticed by Frankland, of traces of free oxygen among the gaseous products of combustion. This occurrence of sulphuric acid in the water residue, even in minute amount, is undoubtedly much to be deprecated, though its effect, at any rate on the carbon determinations, has not seemed to be as great as might have been expected.

9. The combustion process in its present form cannot be considered as "determining" the carbon and nitrogen of the organic matter in water in a sense to justify the claim of "absolute" value for its results which has been denied to those of all other methods. It is but a method of approximation, involving sundry errors, and in part a balance of errors.

10. There is, however, good ground for believing that in many, perhaps most, cases its results for organic carbon may, with proper precautions, be made more valuable than the indications of the permanganate process, and its results for organic nitrogen in like manner more valuable than the indications of the albumenoid-ammonia process.

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† Examples are furnished by Frankland of analyses in which the ammonia correction is very large in comparison with the organic nitrogen.

conducted, especially with the efficiency of the cooling apparatus and the time occupied in the process.

2. In the case of waters containing urea, and also other amidated bodies, such as the leusine and tyrosine occurring among the products of putrefactive decay, some ammonia is so easily formed from these substances by boiling with sodium carbonate, or even without this addition, that it is impossible to distinguish sharply between pre-existing "free" ammonia (of ammoniacal salts) and that formed by the action of alkaline permanganate, the so-called "albumenoid" ammonia. This source of error as to the free ammonia reacts, as has been noticed above, upon the result for organic nitrogen by the combustion process.

3. There is no satisfactory evidence in favour of Wanklyn's view that, in distilling with alkaline permanganate, definite and simple fractions of the nitrogen of organic matter are given off as "albumenoid" ammonia. Such results may be varied at pleasure for most, if not for all, substances, by slight modification of the conditions under which the distillation is conducted.

4. If the distillation with alkaline permanganate be carried out as usual, in accordance with Wanklyn's instructions, it frequently happens that the nitrogenous organic matter is so gradually acted upon as to make the ending of the process indefinite; ammonia is still coming off when the distillation has to be stopped in consequence of the contents of the retort being nearly reduced to dryness. In such cases an unknown fraction of the possible amount of albumenoid ammonia fails to be collected, and is but vaguely indicated by the sign + after the figures recorded.

5. There is evidence that in some cases nitrogenous organic matter is volatilised during the distillation for free ammonia, which, if it had been retained, would have yielded up its nitrogen as albumenoid ammonia; not affecting the Nessler reagent; such nitrogenous matter escapes detection under either head.

6. The albumenoid-ammonia process proper, *i.e.*, the distillation with alkaline permanganate and determination of the ammonia evolved, is admittedly simple and easily carried out with very little preparatory training.

7. The value of the results by this process depends more upon watching the *progress* and *rate* of evolution of the ammonia than upon determining its total amount.

8. Taking the results by this process as recorded, we find a good deal of general similarity between the figures for albumenoid ammonia and those for organic nitrogen (by the combustion process), but with frequent discrepancies of varying extent, such as prevent the one being taken as the accurate measure of the other. (See Tables XIX. and XX., further on.)

SPECIAL CONCLUSIONS AS TO THE PERMANGANATE PROCESS.

The chief points worthy of attention are the following:—

1. The results obtained by the Tidy method (using the acidified permanganate at common temperature) and by that of Kubel (operating at the boiling point) differ irregularly from each other, the latter usually giving much higher figures, as was to be expected, but the ratio between the results by the two methods varies much in different cases.

2. On the whole, there seems usually to be a nearer approach to proportionality with the quantities of organic carbon* found by the combustion process on the part of

* This appears to be the proper way of comparing the results of the permanganate with those of the combustion process. The former process is clearly concerned much more with carbon than nitrogen, if oxygen be usually at all consumed by nitrogen. It is not easy to admit the soundness of the logic with which Tidy (*Jour. Chem. Soc.*, London, January, 1879, 94-97) points to the concordance of results, by the permanganate and combustion processes, and the disagreement with both these of the results by the albumenoid-ammonia process, and hence apparently infers that the two former are trustworthy, and the last not so. He uses the *sum of organic carbon and nitrogen* to represent the results by the combustion process, and as the carbon forms generally much the larger part of this, he

the results afforded by the Kubel process than on that of the Tidy results, but to this there are some very notable exceptions. (See, on this point, Tables XIX. and XX., further on.)

3. In a good many instances the results obtained by the Kubel method are, contrary to the general rule, lower than those afforded by the Tidy method. This seems to be due, in all probability, to loss of organic matter by volatilisation with the escaping steam from the boiling liquid before time has been afforded for action on the permanganate.* An examination of all the results obtained for Nos. 131, 132, and 133, and several other cases, gives good ground for believing this to be the case. Of course, a similar loss may have occurred in other instances, but not to the extent of reversing the general rule as to the results of the Kubel process being larger than those by the method of Tidy; and this may in part explain the absence of any uniform ratio between the figures yielded by those two modifications of the permanganate process.

4. The results obtainable by the Tidy process are liable to variation with the atmospheric temperature prevailing at the time the process is applied.

5. The amount of oxygen consumed by a specimen of water is probably in all ordinary cases much below that required for complete oxidation of the organic matter present, and does not stand in any fixed ratio thereto; it cannot be taken as a measure either of the organic carbon or of the total organic matter. Nevertheless, a distinct general resemblance may be traced between strongly marked results, high or low, as the case may be, for the consumption of oxygen on the one hand, and organic carbon (by the combustion process) on the other; and closer agreement is observable in regard to waters of generally similar character.†

6. The permanganate process is capable of giving more valuable information in regard to a water by watching the *progress* and *rate* of the oxidation of organic matter present than by any single determination of the absolute amount of oxygen consumed in a given time.

7. For such observation of the progress of oxidation the two determinations prescribed by Tidy, *viz.*, of oxygen consumed in one hour and in three hours, respectively, are not sufficient, nor is the latter period of three hours long enough to indicate the general behaviour of the water with acid permanganate.

(To be continued.)

NOTICES OF BOOKS.

Irenicon, No. 2. *Faith, the Life-root of Science, Philosophy, Ethics, and Religion.* By H. GRIFFITH, F.G.S. London: Elliot Stock.

MUCH of the work before us does not fall within the legitimate purview of the CHEMICAL NEWS. Still we find here no little matter which the physicist and chemist not only may, but should, consider, and to which we accordingly feel free to draw attention. Mr. Griffith's fundamental idea appears plainly in the title he has selected, and will by many be regarded as startling, if not absolutely paradoxical. The life-root of Science, say and think many, is by no means faith, but sight, or rather the direct evidence of our senses in general. We believe, say they, what we see and nothing further. They may

naturally arrive at an agreement with the results of the process mainly depending on the oxidation of carbon, and disagreement with those of the process evolving nitrogen as ammonia.

* It is worthy of remark that the largest number of cases among natural waters of the Kubel process giving a lower result than that by the Tidy process occur among the waters believed to be *dangerous*; *i.e.*, Class II.

† In accordance with the remarks of Frankland: "Water Analysis," p. 35.

perhaps, however, if they follow the author be led greatly to modify this opinion.

In two introductory chapters, or lectures, Mr. Griffith gives a condensed sketch of the development of human thought from the days of earliest tradition down to this noisy nineteenth century of ours. The facts herein brought forward are of course not novel, but the author often puts them in a peculiar, instructive light: he quotes writers little—may we say insufficiently—known, and throws out suggestive reflections. In reference to the past he does not endorse the common self-complacent theory which holds that whilst we have learnt much we have forgotten nothing. Picturing a well-equipped steamer wrecked on some savage coast, he says:—"However eloquently its flotsam and jetsam might tell of the possibilities of high civilisation, it would be in language admitting of no translation intelligible to the poor natives. Condensers, compasses, chronometers, aneroids, &c., represent clusters of ideas the most gifted barbarian cannot be expected to understand. Is it certain that the Past never had any inventions quite as far beyond our reach?" In a note he adds—"I know not what theory the reader may hold in respect to the Cyclopean statues and terraces, &c., which have given such world-wide fame to Easter Island. No explanation I have ever yet seen meets half the real difficulties of the case." His estimate of the Middle Ages is not flattering. "Now and again," says he, "Christendom could send out bullies to fight in Palestine, or qualify inquisitors to search for and burn heretics nearer home, but for genuine culture she had no taste, and for progress no feeling save that of horror."

A survey of the Baconian movement leads the author to the principle—or, as he calls it, the very soul—of Science, that whereby it is differentiated from mere floating opinion, *i.e.*, strict verification." This principle of strict and humble submission to facts he traces as equally essential in Science and in Morals. Whilst recognising the freedom of will, he declares that "none the less has it necessities and sequences of its own, essentially incompatible with the notion of chaos." "If the increment of crystals is subject to specific regulations, so is the growth of vegetables and animals, and we need not scruple to add, so also is the growth of mind and character, each in its own order." "Be their spheres of action ever so widely apart, and there factors ever so incommensurable, it is utterly impossible to believe that a good man is a whit less *orderly* a production than a good watch or a good steam-engine." Chance as a maker or manipulator of anything he utterly discards, admitting of course that Nature has mysteries innumerable. "Of practical solecisms or absolute lawlessness Science has never been able to detect a vestige." Time, he considers, has problems of its own still more difficult than those of space, and there are other cases where the antecedent and consequent seem to run on such different planes that we have no common data for determining their mutual relation. Among the difficulties which scientific men encounter he enumerates isomerism and catalysis. As regards the former we must remark that a diverse arrangement of molecules, once suggested as a tentative hypothesis to explain why bodies alike in percentage composition should possess such different properties, is now established on fairly tenable ground. At least by working on this supposition the organic chemist arrives at correct results. Catalysis, instead of being explained, is being set aside as an unnecessary hypothesis.

In the third chapter the author comes to the "Principles and Method of Induction." Whilst accepting this method "ungrudgingly, and even with heartiest thankfulness," he holds—and very justly—that there is room for caution as to the manner in which we apply it. Here he is led to an appreciation of Positivism, Comtism, or as it is now sometimes called, Cosmism. From a variety of familiar instances he shows that the utmost caution is needed in arguing from the few instances observed to the many, or all, possibly existing cases. He asks what is the immediate, exact evidence on which we

rely in asserting that the consequences of falling from the top of the Monument, or of swallowing a strong dose of prussic acid, would be mortal? *Experience*, he contends, can only cover the past, or rather only that part of it with which the observer has been personally brought into contact, but "as applied to the future it is a word without meaning, unless we keep in the background some such postulate as this, that whatsoever has been will, under like circumstance, be repeated. But in making this postulate we are 'walking by faith, not by sight.'"

It is impossible to confine thought within the narrow sphere of Positivism. The mere registering of phenomena, however important, is but a small part of the interpretation of Nature. As Professor Huxley observes—"The term 'positive' as implying a system of thought which assumes nothing beyond the content of observed facts implies that which never did exist and never will." We shall be the more inclined to reject Comte as a guide if we remember that he upheld the principle of exclusively binary combination in chemistry, just as it was about to be discarded by chemists; that he declared himself for the individual origin of organic forms just on the eve of the avatar of Evolutionism; that he and his followers speak but contemptuously of pure research, and that they are perfectly willing to place difficulties in its way.

Warned that we have already nearly exhausted our space, we are compelled to overlook many suggestive, and in some respects humiliating, instances of what, in our scientific researches, we are obliged to take upon trust, or upon the testimony of others. It is even to the mightiest minds wholesome to be reminded of such truths.

We must recommend "Faith" to the serious attention at once of students and of masters in science. Whether they can accept all its teachings or not, it will assuredly purify their intellectual atmosphere.

Water Works Statistics, 1882; Second Issue. Gas Works Statistics, 1882; Fourth Issue. The Gas and Water Companies Directory, 1882; Sixth Issue. Edited by CHARLES W. HASTINGS. London: The Scientific Publishing Company.

THESE three manuals will be of great use to all persons connected with municipal affairs or interested in sanitary movements. As far as we have been able to test the information given it is exceedingly correct, though in many cases the author has not been able to obtain particulars of the water or gas works. We find no mention of the Aylesbury Water Works (Chiltern Hills) at all. We are glad to see that the principle of a constant supply is now adopted in a great majority of towns and districts.

OBITUARY.

PROF. W. STANLEY JEVONS, F.R.S.

WE are inexpressibly shocked and distressed at learning the untimely death of Professor W. Stanley Jevons, F.R.S., who was drowned on Monday last whilst bathing in the sea near the village of Bexhill, in Sussex.

B. J. GROSJEAN, F.C.S., &c.

WE regret having to record the death of Mr. J. J. Beaumont Jeanneret Grosjean, F.C.S., F.I.C., an occasional contributor to the *CHEMICAL NEWS*. The deceased gentleman, who was only in his fortieth year, held the position of Chemist at the Manure Works of Messrs. J. B. Lawes and Co., and was justly regarded as an authority concerning the applications of chemistry to agriculture. We understand that his papers have been placed in the hands of Mr. Warrington for publication.

CORRESPONDENCE.

DETERMINATION OF ARSENIC IN COPPER.

To the Editor of the Chemical News.

SIR,—As Dr. Watson's note in the CHEMICAL NEWS (vol. xlv., p. 46) makes a charge of dishonesty against me, I feel sure that you will allow me space for a reply.

With regard to the use of iron as a means of separating arsenic, I of course make no claim whatever to that. It has long been known that ferrichydrate precipitated by ammonia carries down the arsenic; indeed, I believe it is given by Fresenius as a general method of separating arsenic from the metals not precipitated by ammonia.

The only point I do claim is the substitution of sodium acetate for ammonia, and I feel quite certain that not only was this change not suggested or even hinted to me by Dr. Watson, but that it was on my suggestion that it was introduced into the laboratory. The after operations are practically identical with Abel and Field's method.

Since any value there may be in my note will be in the matter and not in the author, and since petty disputes as to priority can be of no interest to your readers, I much regret being compelled to thus occupy your valuable space.—I am, &c.,

A. HUMBOLDT SEXTON.

Burslem, August 14, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 4, July 24, 1882.

New Researches on the Propagation of Explosive Phenomena in Gases.—The speed of translation of the gaseous molecules preserving the totality of the *vis viva* which corresponds to the heat liberated by the reaction, may be regarded as a limit representing the maximum speed of propagation of the explosive wave. But this speed is diminished by contact with gases and other foreign bodies, and equally so when the mass ignited is too small, and is too rapidly cooled by radiation, and also when the elementary speed of the chemical reaction is too feeble, as may happen with carbonic oxide. In these conditions there is a retardation of the wave, and it may even cease to reproduce itself, the combustion then propagating itself according to a much slower law.

Separation of Gallium.—Lecoq de Boisbaudran.—See p. 69.

Chemical Work Produced by the Battery.—D. Tommasi.—It results from the author's experiments that a chromic acid element, as employed by Favre, that is to say, having a positive electrode of platinum, produces an external chemical work only equal to about 65 cal. If in the same element we substitute for platinum, carbon or platinum sponge, about 85 cal. may be rendered transmissible to the circuit, or 20 cal. more than in the former element.

Variation of Friction Produced by Voltaic Polarisation.—M. Krouchkoll.—The attention of physicists has been called to a new fact, the variation in the friction of a metallic surface against an electrolyte when a current is passed between the two bodies. According to M. Koch (*Wiedemann's Annalen*, 1879, p. 92), polarisation by means of oxygen affects the rubbing surface of palladium or platinum so as to increase the friction, whilst polarisation by means of hydrogen produces no effect.

The author finds that polarisation by means of oxygen increases the friction, whilst polarisation with hydrogen diminishes it.

Amplitude of Telephonic Vibrations.—G. Salet.—The amplitude of the vibrations of the receiving plate is from 2 to 3 ten-thousandths of a millimetre.

Use of Crushing-Manometers for the Measurement of the Pressures Developed by Explosives.—MM. Sarrau and Vieille.—This paper does not admit of useful abstraction.

Reproduction of Calcite and Witherite.—MM. Miron and Bruneau.—The authors have obtained calcite by aspirating air charged with ammoniacal gas through river water. Witherite was produced by using distilled water charged with barium carbonate held in solution by means of carbonic acid.

Evaporation of Metals in a Vacuum.—E. Demargay.—All the metals which the author has examined have given signs of volatilisation at temperatures relatively very low. The author is continuing his researches, and hopes to lay before the Academy proofs of the volatilisation of metals of the iron and platinum groups at temperatures much lower than are generally supposed.

Determination of Astringent Matters in Wines.—Aimé Girard.—The author considers that none of the known methods are trustworthy when the proportion of astringent matter to be determined is small. He uses as a reagent the bowels of sheep, such as are used for fiddle-strings; not in the state in which they are met with in commerce, but before they have undergone the final polishing in oil. White strings of the best quality should be taken. The author operates upon 100 c.c. of wine, diluting it with water if it contains much organic matter. Four or five strings are taken, and a known portion, 1 grm., is cut off for the determination of water. A quantity of the same strings is taken, from 3 to 5 grms., according to the quality of the wine. The weighed portion is put to steep in water for four or five hours, until the cords swell, and can be easily untwisted by hand. They are then put into the wine to be analysed. After about twenty-four to forty-eight hours, the wine has entirely lost its colour, and the addition of ferric chloride no longer produces any reaction. The strings are then washed twice or thrice with distilled water, and dried at first at 35° to 40° in a flat vessel. When they are no longer adhesive they are placed in a bottle, which can be easily stoppered, and the drying is finished at a temperature which must not exceed 100° to 102°. The increase of weight, due allowance having been made for the moisture originally present, shows the proportion of ceno-tannin and colouring-matter contained in the wine.

The Law of the Congelation of the Solutions of Neutral Substances in Benzol.—F. M. Raoult.—The acetons, aldehyds, ethers, hydrocarbides, and their derivatives, dissolved in one and the same quantity of benzol in proportion to their molecular weights, all lower the point of congelation of this liquid by about the same number of degrees. In a multitude of cases the lowering of the congelation-point of a solvent depends merely on the relation between the numbers of the molecules of the dissolved body and of the solvent; it is independent of the nature, the number, and the arrangement of the atoms which compose the dissolved molecules.

Bulletin de la Société Chimique de Paris.
June 5, 1882.

Chromium Phosphate and its Utilisation in Analysis and in the Arts.—A. Carnot.—Already noticed.

Researches on Glycolic Ether and on the Ethylene Oxides.—M. Berthelot.—A thermo-chemical paper which has been already noticed.

Hydrochloric Ether of Glycol.—M. Berthelot.—Already noticed.

Russian Chemical Society.—Session May 7th to 19th, 1881.—M. A. Krakau.

M. Beketoff sent in a preliminary notice on potassium protoxide. He finds that metallic potassium is without action upon potassium hydrate.

M. Barsilowsky doubts the existence of the two compounds obtained by Mr. Perkin on oxidising para-toluidine.

M. Menchoutkine affirms that the study of the formation of the compound ethers may contribute to the solution of various questions relative to the chemical structure of these bodies.

M. Wilm announces researches on the metals of the platinum group.

M. Pawlinoff announces that on agitating aniline with methyl-iodide and an excess of potassium hydroxide in an aqueous solution, there is development of heat and production of $C_6H_5(CH_3)_3NI$.

M. Almedingen on agitating crotonylene with sulphuric acid at common temperatures, obtains hexa-methylbenzol, a white crystalline substance, melting at 163° .

M. Lwoff adds that the crotonylene studied by M. Almedingen was prepared two years ago by Mlle. Lermontoff.

M. Kutcheroff pointed out a new method of hydrating the hydrocarbons of the acetylenic series by means of mercury bromide.

The *Journal of the Russian Chemical Society*, vol. xiii., part 6, contains the following memoirs:—On anhydrous potassium oxide, M. Beketoff; Action of zinc-methyl upon the mono-, di-, and tri-acetyl chlorides, M. Bogomoletz; On the laws of double decomposition, M. Potilitzine; On the terebene derivative of diamylene, M. Tougolessoff; On the preparation of tri-methyl-phenyl-ammonium, M. Pawlinoff; On the azo-derivatives of toluene, M. Barsilowsky.

Justus Liebig's Annalen der Chemie,
Band 212, Heft 3.

Chemical Theory of Gunpowder.—H. Debus.—The first part of a memoir read before the Royal Society.

Hydrazine Compounds.—Emil Fischer.—In this third section the author examines, first, the sulphureas of phenyl-hydrazine, in particular diphenyl-sulpho-carbazone, its oxidation, its reduction; phenyl-sulpho-semi-carbazide, phenyl-sulpho-carbazine, with its salts and derivatives; secondly, the hydrazin-benzoic acids, ortho-hydrazin-benzoic anhydride, para-hydrazin-benzoic acid; and thirdly, ortho-tolyl-hydrazine.

Compounds of Phthalic Acid with the Phenols.—Adolf Baeyer.—In this fourth section of the memoir we find an account of para-cresol-phthalein-anhydride, of the anhydride of para-cresol-naphthaline, the scission-products of phthaleine anhydride on fusion with potassa, and the condensation-products obtained by the action of concentrated sulphuric acid. In a second part the author discusses phenol-phthaleine anhydride and the constitution of fluoresceine.

Band 213, Heft 1.

Chemical Composition of the Minerals of the Cryolite Group.—Josef Brandl.—These researches comprehend analyses of the minerals cryolite, pachnolite, Thomsenolite, Ralstonite, and chiolite, as well as of propopite and fluellite.

Chemical Theory of Gunpowder.—H. Debus.—A continuation.

The Crystalline Water of Calcium Butyrate and its Curve of Solubility.—Otto Hecht.—The calcium salt obtained in crystals from solutions between 6° and 80° contain one molecule of water, which they lose slowly at 100° , but readily at 110° . Calcium butyrate becomes less soluble at higher temperatures, but, unlike other salts possessing this property, the crystals formed at high

temperatures contain the same quantity of water as those formed at lower temperatures.

Molecular Refraction of Liquid Organic Compounds.—H. Landolt.—Not capable of useful abstraction.

Communications from the Chemical Laboratory of the University of Graz.—These consist of a paper by L. Pebal and G. Schacherl on the vapour-density of hypochloric acid, and a memoir by Julius Domac on the action of hypochloric acid upon hexylene.

Moniteur Scientifique, Quesneville,
July, 1882.

Contribution to the Study of the Cerite Metals.—Dr. Bohuslav Brauner.—We shall endeavour to give in full the most important parts of this long and valuable memoir.

Patents taken Abroad.—A list of specifications of chemical patents, chiefly German.

Condensation-Products of the Fatty Acids.—H. de Pechmann.—A translation from the *Berichte der Deutsch. Chem. Gesellschaft*.

Studies on Caffeine and Theo-bromine.—MM. Maly, Hinteregger, and Andreasch.—In this memoir the authors consider the action of bromine and water upon caffeine, and the formation of dimethyl-alloxane, apocaffeine, and cafuric and dimethyl-dialuric acids.

Condensation-Products of the Aromatic Bases.—O. Fischer.

Derivatives of Quinoleine.—Z. H. Skraup.

Transformation of α - and β -Naphthol into Naphthylamines.—A. Calm.

Anthramine.—MM. Liebermann and Bollert.

Halogenous Derivatives of Quinoleine.—W. al Coste.

Colouring-Matters derived from Resorcline.—G. Damm and L. Schreiner.

Preparation of Azo-oxy-benzol.—H. Klinger.

Compounds of the Indigotie Group.—A. Baeyer.—These eight papers are abstracts from the *Berlin Berichte*.

Certain Practical Considerations on Recent Researches on Nitrification.—R. Warington.—A translation of a paper read before the Society of Arts.

Contribution to the Study of Antiseptics.—Fr. Boillat.—From the *Journal für Praktische Chemie*.

Detection of Sugar in the Urine: Principal Causes of Error.—A. Robin.—If the patient has absorbed terebenthoid compounds there is found in the urine an unknown body which some chemists approximate to formic acid, but which reduces Fehling's liquid, as does sugar, and even bismuth subnitrate heated with caustic potassa. The urine of persons who have taken chloral or chloroform:—In urines loaded with urates and uric acid Fehling's liquid turns green and yellow, becomes turbid, and especially if the liquid is kept long at a boil a precipitate is deposited quite similar to that of cuprous oxide reduced by diabetic sugar. The reactions may, however, be thus distinguished: The reduction effected by sugars produces a precipitate which is from the beginning pulverulent, and is of a bright red or yellow, and afterwards takes a brownish or blackish colour, but has no resemblance to the whitish, flocculent precipitate, which appears in a urine charged with urates. The distinction is most easy at the outset of the reaction. When Fehling's liquid is rendered turbid by urates there appear in it isolated clouds, between which the liquid remains limpid. With caustic potassa the causes of error are less numerous. However, if a urine contains blood, the colouring-matter of the blood if heated with potassa may darken almost to blackness, but it is still a reddish or purple-brown, differing in tint from that given by diabetic sugar.

THE CHEMICAL NEWS.

VOL. XLVI. No. 1187.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SOUTHAMPTON MEETING, AUGUST 23, 1882.

INAUGURAL ADDRESS OF THE PRESIDENT,

C. WILLIAM SIEMENS, D.C.L. (Oxon), LL.D. (Glasgow and Dublin), Ph.D., F.R.S., F.C.S., Member Inst. C.E.

IN venturing to address the British Association from this chair, I feel that I have taken upon myself a task involving very serious responsibility. The Association has for half a century fulfilled the important mission of drawing together, once every year, scientists from all parts of the country for the purpose of discussing questions of mutual interest, and of cultivating those personal relations which aid so powerfully in harmonising views, and in stimulating concerted action for the advancement of science.

A sad event casts a shadow over our gathering. While still mourning the irreparable loss Science has sustained in the person of Charles Darwin, whose bold conceptions, patient labour, and genial mind made him almost a type of unsurpassed excellence, telegraphic news reached Cambridge, just a month ago, to the effect that our Honorary Secretary, Professor F. M. Balfour, had lost his life during an attempted ascent of the Aiguille Blanche de Penteret. Although only thirty years of age, few men have won distinction so rapidly and so deservedly. After attending the lectures of Michael Foster, he completed his studies of biology under Dr. Anton Dohrn at the Zoological Station of Naples, in 1875. In 1878 he was elected a Fellow, and in November last a member of Council of the Royal Society, when he was also awarded one of the Royal Medals for his embryological researches. Within a short interval of time Glasgow University conferred on him their honorary degree of LL.D., he was elected President of the Cambridge Philosophical Society, and after having declined very tempting offers from the Universities of Oxford and Edinburgh, he accepted a professorship of Animal Morphology created for him by his own University. Few men could have borne without hurt such a stream of honourable distinctions, but in young Balfour genius and independence of thought were happily blended with industry and personal modesty; these won for him the friendship, esteem, and admiration of all who knew him.

Since the days of the first meeting of the Association in York, in 1831, great changes have taken place in the means at our disposal for exchanging views, either personally or through the medium of type. The creation of the railway system has enabled congenial minds to attend frequent meetings of those special Societies which have sprung into existence since the foundation of the British Association, amongst which I need only name here the Physical, Geographical, Meteorological, Anthropological, and Linnean, cultivating abstract science, and the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Society of Telegraph Engineers and Electricians, the Gas Institute, the Sanitary Institute, and the Society of Chemical

Industry, representing applied science. These meet at frequent intervals in London, whilst others, having similar objects in view, hold their meetings at the University towns, and at other centres of intelligence and industry throughout the country, giving evidence of great mental activity, and producing some of those very results which the founders of the British Association wished to see realised. If we consider, further, the extraordinary development of scientific journalism which has taken place, it cannot surprise us when we meet with expressions of opinion to the effect that the British Association has fulfilled its mission, and should now yield its place to those special Societies it has served to call into existence. On the other hand, it may be urged that the brilliant success of last year's Anniversary Meeting, enhanced by the comprehensive address delivered on that occasion by my distinguished predecessor in office, Sir John Lubbock, has proved, at least, that the British Association is not dead in the affections of its members, and it behoves us at this, the first ordinary gathering in the second half-century, to consider what are the strong points to rely upon for the continuance of a career of success and usefulness.

If the facilities brought home to our doors of acquiring scientific information have increased, the necessities for scientific enquiry have increased in a greater ratio. The time was when science was cultivated only by the few, who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others, who, with only commercial aims in view, did not aspire to further the objects of science for its own sake, but thought only of benefiting by its teachings. Progress could not be rapid under this condition of things, because the man of pure science rarely pursued his enquiry beyond the mere enunciation of a physical or chemical principle, whilst the simple practitioner was at a loss how to harmonise the new knowledge with the stock of information which formed his mental capital in trade.

The advancement of the last fifty years has, I venture to submit, rendered theory and practice so interdependent that an intimate union between them is a matter of absolute necessity for our future progress. Take, for instance, the art of dyeing, and we find that the discovery of new colouring-matters derived from waste-products, such as coal-tar, completely changes its practice, and renders an intimate knowledge of the science of chemistry a matter of absolute necessity to the practitioner. In telegraphy and in the new arts of applying electricity to lighting, to the transmission of power, and to metallurgical operations, problems arise at every turn, requiring for their solution not only an intimate acquaintance with, but a positive advance upon, electrical science, as established by purely theoretical research in the laboratory. In general engineering the mere practical art of constructing a machine so designed and proportioned as to produce mechanically the desired effect, would suffice no longer. Our increased knowledge of the nature of the mutual relations between the different forms of energy makes us see clearly what are the theoretical limits of effect; these, although beyond our absolute reach, may be looked upon as the asymptotes to be approached indefinitely by the hyperbolic course of practical progress, of which we should never lose sight. Cases arise, moreover, where the introduction of new materials of construction, or the call for new effects, renders former rules wholly insufficient. In all these cases practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end.

Far be it from me to think lightly of the ardent students of nature, who, in their devotion to research, do not allow their minds to travel into the regions of utilitarianism and of self-interest. These, the high priests of science, command our utmost admiration; but it is not to them that we can look for our current progress in practical science, much less can we look for it to the "rule of

thumb" practitioner, who is guided by what comes nearer to instinct than to reason. It is to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day, both merging more and more into one class, that of pioneers in the domain of nature. It is such men that Archimedes must have desired when he refused to teach his disciples the art of constructing his powerful ballistic engines, exhorting them to give their attention to the principles involved in their construction, and that Telford, the founder of the Institution of Civil Engineers, must have had in his mind's eye, when he defined civil engineering as "the art of directing the great sources of power in nature."

These considerations may serve to show that although we see the men of both abstract and applied science group themselves in minor bodies for the better prosecution of special objects, the points of contact between the different branches of knowledge are ever multiplying, all tending to form part of a mighty tree—the tree of modern science under whose ample shadow its cultivators will find it both profitable and pleasant to meet, at least once a year; and considering that this tree is not the growth of one country only, but spreads both its roots and branches far and wide, it appears desirable that at these yearly gatherings other nations should be more fully represented than has hitherto been the case. The subjects discussed at our meetings are without exception of general interest, but many of them bear an international character, such as the systematic collection of magnetic, astronomical, meteorological, and geodetical observations, the formation of a universal code for signalling at sea, and for distinguishing lighthouses, and especially the settlement of scientific nomenclatures and units of measurement, regarding all of which an international accord is a matter of the utmost practical importance.

As regards the measures of length and weight it is to be regretted that this country still stands aloof from the movement initiated in France towards the close of last century; but, considering that in scientific work metrical measure is now almost universally adopted, and that its use has been already legalised in this country, I venture to hope that its universal adoption for commercial purposes will soon follow as a matter of course. The practical advantages of such a measure to the trade of this country would, I am convinced, be very great, for English goods, such as machinery or metal rolled to current sections, are now almost excluded from the Continental market, owing to the unit measure employed in their production. The principal impediment to the adoption of the metre consists in the strange anomaly that although it is legal to use that measure in commerce, and although a copy of the standard metre is kept in the Standards' Department of the Board of Trade, it is impossible to procure legalised rods representing it, and to use a non-legalised copy of a standard in commerce is deemed fraudulent. Would it not be desirable that the British Association should endeavour to bring about the use in this country of the metre and kilogramme, and, as a preliminary step, petition the Government to be represented on the International Metrical Commission, whose admirable establishment at Sèvres possesses, independently of its practical work, considerable scientific interest, as a well-found laboratory for developing methods of precise measurement?

Next in importance to accurate measures of length, weight, and time, stand, for the purposes of modern science, those of electricity.

The remarkably clear lines separating conductors from non-conductors of electricity, and magnetic from non-magnetic substances, enable us to measure electrical quantities and effects with almost mathematical precision; and, although the ultimate nature of this, the youngest scientifically investigated form of energy, is yet wrapt in

mystery, its laws are the most clearly established, and its measuring instruments (galvanometers, electrometers, and magnetometers), are amongst the most accurate in physical science. Nor could any branch of science or industry be named in which electrical phenomena do not occur, to exercise their direct and important influence.

If, then, electricity stands foremost amongst the exact sciences, it follows that its unit measures should be determined with the utmost accuracy. Yet, twenty years ago, very little advance had been made towards the adoption of a rational system. Ohm had, it is true, given us the fixed relations existing between electromotive force, resistance, and quantity of current; Joule had established the dynamical equivalent of heat and electricity, and Gauss and Weber had proposed their elaborate system of absolute magnetic measurement. But these invaluable researches appeared only as isolated efforts, when, in 1862, the Electric Unit Committee was appointed by the British Association, at the instance of Sir William Thomson, and it is to the long-continued activity of this Committee that the world is indebted for a consistent and practical system of measurement, which, after being modified in details, received universal sanction last year by the International Electrical Congress assembled at Paris.

At this Congress, which was attended officially by the leading physicists of all civilised countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries, and the magnetic or dynamical system developed by the British Association, also between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The Congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an International Committee, to be appointed by the representatives of the several governments; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labour is utilised; only, instead of expressing electrical quantities directly in absolute measure, the Congress has embodied a consistent system, based on the Ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereafter know as the "practical system," as distinguished from the "absolute system," the units are named after leading physicists, the Ohm, Ampère, Volt, Coulomb, and Farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "Weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the Congress in order to avoid the risk of confusion in the magnitude of the unit current with which his name had been formerly associated.

The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an Ampère through the difference of potential of a Volt is the unit consistent with the practical system. It might be appropriately called a Watt, in honour of that master mind in mechanical science, James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A Watt, then, expresses the rate of an Ampère multiplied by a Volt, whilst a horse-power is 746 Watts, and a Cheval de Vapeur 735.

The system of electro-magnetic units would then be:—

	C.G.S. Units.
(1) Weber, the unit of magnetic quantity	= 10^8
(2) Ohm, " " resistance	= 10^9
(3) Volt, " " electromotive force	= 10^8
(4) Ampère " " current	= 10^{-1}
(5) Coulomb " " quantity	= 10^{-1}
(6) Watt " " power	= 10^7
(7) Farad " " capacity	= 10^{-9}

The word Energy was first used by Young in a scientific sense, and represents a conception of recent date, being the outcome of the labours of Carnot, Mayer, Joule, Grove, Clausius, Clerk-Maxwell, Thomson, Stokes, Helmholtz, Macquorn-Rankine, and other labourers, who have accomplished for the science regarding the forces in Nature what we owe to Lavoisier, Dalton, Berzelius, Liebig, and others, as regards Chemistry. In this short word Energy we find all the efforts in nature, including electricity, heat, light, chemical action, and dynamics, equally represented, forming, to use Dr. Tyndall's apt expression, so many "modes of motion." It will readily be conceived that when we have established a fixed numerical relation between these different modes of motion, we know beforehand what is the utmost result we can possibly attain in converting one form of energy into another, and to what extent our apparatus for effecting the conversion falls short of realising it. The difference between ultimate theoretical effect and that actually obtained is commonly called loss, but, considering that energy is indestructible, represents really secondary effect which we obtain without desiring it. Thus friction in the working parts of a machine represents a loss of mechanical effect, but is a gain of heat, and in like manner the loss sustained in transferring electrical energy from one point to another is accounted for by heat generated in the conductor. It sometimes suits our purpose to augment the transformation of electrical into heat energy at certain points of the circuit when the heat rays become visible, and we have the incandescence electric light. In effecting a complete severance of the conductor for a short distance, after the current has been established, a very great local resistance is occasioned, giving rise to the electric arc, the highest development of heat ever attained. Vibration is another form of lost energy in mechanism, but who would call it a loss if it proceeded from the violin of a Joachim or a Norman-Neruda?

Electricity is the form of energy best suited for transmitting an effect from one place to another; the electric current passes through certain substances—the metals—with a velocity limited only by the retarding influence caused by electric charge of the surrounding dielectric, but approaching probably under favourable conditions that of radiant heat and light, or 300,000 kilometres per second; it refuses, however, to pass through oxidised substances, glass, gums, or through gases except when in a highly rarefied condition. It is easy therefore to confine the electric current within bounds, and to direct it through narrow channels of extraordinary length. The conducting wire of an Atlantic cable is such a narrow channel; it consists of a copper wire, or strand of wires, 5 m.m. in diameter, by nearly 5000 kilometres in length, confined electrically by a coating of guttapercha about 4 m.m. in thickness. The electricity from a small galvanic battery passing into this channel prefers the long journey to America in the good conductor, and back through the earth, to the shorter journey across the 4 m.m. in thickness of insulating material. By an improved arrangement the alternating currents employed to work long submarine cables do not actually complete the circuit, but are merged in a condenser at the receiving station after having produced their extremely slight but certain effect upon the receiving instrument. So perfect is the channel and so precise the action of both the transmitting and receiving instruments employed, that two systems of electric signals may be passed simultaneously through the same cable in opposite directions, producing independent records at

either end. By the application of this duplex mode of working to the Direct United States cable under the superintendence of Dr. Muirhead, its transmitting power was increased from twenty-five to sixty words a minute, being equivalent to about twelve currents or primary impulses per second.

The minute currents here employed are far surpassed as regards delicacy and frequency by those revealed to us by that marvel of the present day, the telephone. The electric currents caused by the vibrations of a diaphragm acted upon by the human voice, naturally vary in frequency and intensity according to the number and degree of those vibrations, and each motor current in exciting the electro-magnet forming part of the receiving instrument, deflects the iron diaphragm occupying the position of an armature to a greater or smaller extent according to its strength. Savart found that the fundamental *la* springs from 440 complete vibrations in a second, but what must be the frequency and modulations of the motor current and of magnetic variations necessary to convey to the ear through the medium of a vibrating armature, such a complex of human voices and of musical instruments as constitutes an opera performance. And yet such performances could be distinctly heard and even enjoyed as an artistic treat by applying to the ears a pair of the double telephonic receivers at the Paris Electrical Exhibition, when connected with a pair of transmitting instruments in front of the footlights of the Grand Opera. In connection with the telephone, and with its equally remarkable adjunct, the microphone, the names of Riess, Graham Bell, Edison, and Hughes will ever be remembered.

Regarding the transmission of power to a distance the electric current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope as used at Schaffhausen to utilise the power of the Rhine fall. The transformation of electrical into mechanical energy can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires; these in a properly designed dynamo-electric machine do not exceed 10 per cent, as shown by Dr. John Hopkinson, and, judging from recent experiments of my own, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination for safety's sake, and assuming the same percentage in re-converting the current into mechanical effect, a total loss of 19 per cent results. To this loss must be added that through electrical resistance in the connecting line wires, which depends upon their length and conductivity, and that due to heating by friction of the working parts of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of $100 - 38 = 62$ per cent, attainable at a distance, which agrees with experimental results, although in actual practice it would not be safe at present to expect more than 50 per cent of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power the loss cannot be taken at less than 50 per cent, and as it depends upon fluid resistance it increases with distance more rapidly than in the case of electricity. Taking the loss of effect in all cases at 50 per cent, electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarisation; but as this second conductor need not be insulated, water or gas pipes, railway metals or fencing wire, may be called into requisition for the purpose. The small space occupied by the electro-motor, its high working speed, and the absence of waste products, render it specially available for the general distribution of power to cranes and light machinery of every description. A

loss of effect of 50 per cent. does not stand in the way of such applications, for it must be remembered that a powerful central engine of best construction produces motive power with a consumption of two pounds of coal per horsepower per hour, whereas small engines distributed over a district would consume not less than five; we thus see that there is an advantage in favour of electric transmission as regards fuel, independently of the saving of labour and other collateral benefits.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and the fields from one centre. Having worked such a system myself in combination with electric lighting and horticulture for upwards of two years, I can speak with confidence of its economy, and of the facility with which the work is accomplished in charge of untrained persons.

As regards the effect of the electric light upon vegetation there is little to add to what was stated in my paper read before Section A last year, and ordered to be printed with the Report, except that in experimenting upon wheat, barley, oats, and other cereals sown in the open air, there was a marked difference between the growth of the plants influenced and uninfluenced by the electric light. This was not very apparent till towards the end of February, when, with the first appearance of mild weather, the plants under the influence of an electric lamp of 4000 candle-power placed about 5 metres above the surface, developed with extreme rapidity, so that by the end of May they stood above 4 feet high, with the ears in full bloom, when those not under its influence were under 2 feet in height, and showed no sign of the ear.

In the electric railway first constructed by Dr. Werner Siemens, at Berlin, in 1879, electric energy was transmitted to the moving carriage or train of carriages through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well creosoted cross sleepers. At the Paris Electrical Exhibition the current was conveyed through two separate conductors making sliding or rolling contact with the carriage, whereas in the electric railway now in course of construction in the north of Ireland (which, when completed, will have a length of twelve miles), a separate conductor will be provided by the side of the railway, and the return circuit completed through the rails themselves, which in that case need not be insulated; secondary batteries will be used to store the surplus energy created in running downhill, to be restored in ascending steep inclines, and for passing roadways where the separate insulated conductor is not practicable. The electric railway possesses great advantages over horse or steam-power for towns, in tunnels, and in all cases where natural sources of energy, such as waterfalls, are available; but it would not be reasonable to suppose that it will in its present condition compete with steam propulsion upon ordinary railways.

The deposition of metals from their solutions is perhaps the oldest of all useful applications of the electric current, but it is only in very recent times that the dynamo current has been practically applied to the refining of copper and other metals, as now practised at Birmingham and elsewhere, and upon an exceptionally large scale at Ocker, in Germany. The dynamo machine there employed was exhibited at the Paris Electrical Exhibition, its peculiar feature being that the conductors upon the rotating armature consisted of solid bars of copper 30 m.m. square, in section, which were found only just sufficient to transmit the large quantity of electricity of low tension necessary for this operation. One such machine consuming 4-horse power deposits about 300 kilogrammes of copper per 24 hours; the motive power at Ocker is derived from a waterfall.

Electric energy may also be employed for heating purposes, but in this case it would obviously be impossible for it to compete in point of economy with the direct combustion of fuel for the attainment of ordinary degrees of heat. Bunsen and Ste.-Claire De Ville have taught us, however, that combustion becomes extremely sluggish

when a temperature of 1800° C. has been reached, and for effects at temperatures exceeding that limit the electric furnace will probably find advantageous applications. Its specific advantage consists in being apparently unlimited in the degree of heat attainable, thus opening out a new field of investigation to the chemist and metallurgist. Tungsten has been melted in such a furnace, and 8 pounds of platinum have been reduced from the cold to the liquid condition in 20 minutes.

The largest and most extensive application of electric energy at the present time is to lighting, but, considering how much has of late been said and written for and against this new illuminant, I shall here confine myself to a few general remarks. Joule has shown that if an electric current is passed through a conductor, the whole of the energy lost by the current is converted into heat; or, if the resistance be localised, into radiant energy comprising heat, light, and actinic rays. Neither the low heat rays nor the ultra-violet of highest refrangibility affect the retina, and may be regarded as lost energy, the effective rays being those between the red and violet of the spectrum, which in their combination produce the effect of white light.

Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1700° C., formed $\frac{1}{4}$ th part of the total radiant energy emitted, and $\frac{1}{10}$ th part in the case of an arc light worked by a battery of 50 Grove's elements. In order to apply these valuable data to the case of electric lighting by means of dynamo-currents, it is necessary in the first place to determine what is the power of 50 Grove's elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electro-motive force of 98.5 Volts, and an internal resistance of 13.5 Ohms, giving a current of 7.3 Amperes when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 Ohms, the current produced in the arc would be 4 Amperes (allowing one Ohm for the leads), and the power consumed 160 Watts; the light power of such an arc would be about 150 candles, and, comparing this with an arc of 3308 candles produced by 1162 Watts, we find that 7.3 times the electric energy produce 22 times the amount of light measured horizontally. If, therefore, in Dr. Tyndall's arc $\frac{1}{4}$ th of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3300 candles, fully $\frac{1}{4}$ are luminous rays. In the case of the incandescence light (say a Swan light of 20 candle power) we find in practice that 9 times as much power has to be expended as in the case of the arc light; hence $\frac{1}{7}$ part of the power is given out as luminous rays, as against $\frac{1}{4}$ th in Dr. Tyndall's incandescent platinum—a result sufficiently approximate considering the wide difference of conditions under which the two are compared.

These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature, and light produced, which may serve as a means to determine temperatures exceeding the melting point of platinum with greater accuracy than has hitherto been possible by actinimetric methods in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly over-estimated.

The principal argument in favour of the electric light is furnished by its immunity from products of combustion which not only heat the lighted apartments, but substitute carbonic acid and deleterious sulphur compounds for the oxygen upon which respiration depends; the electric light

is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery; this, although not embodying a new conception, has lately been greatly improved in power and constancy by Planté, Faure, Volckmar, Sellon, and others, and promises to accomplish for electricity what the gas-holder has done for the supply of gas and the accumulator for hydraulic transmission of power.

It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that even should its cost be found greater than that of gas, it will be preferred for the lighting of drawing-rooms and dining-rooms, theatres and concert-rooms, museums, churches, warehouses, show-rooms, printing establishments and factories, and also the cabins and engine-rooms of passenger steamers. In the cheaper and more powerful form of the arc light, it has proved itself superior to any other illuminant for spreading artificial daylight over the large areas of harbours, railway stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operation both by sea and land.

The electric light may be worked by natural sources of power, such as waterfalls, the tidal wave, or the wind, and it is conceivable that these may be utilised at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of those sources of energy, and the facility offered by electrical conduction in rendering them available for lighting and power-supply, while Sir William Thomson made this important matter the subject of his admirable address to Section A last year at York, and dealt with it in an exhaustive manner.

The advantages of the electric light and of the distribution of power by electricity have lately been recognised by the British Government, who have just passed a Bill through Parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or other will in each application be decided upon grounds of relative convenience, but I venture to think that gas-lighting will hold its own as the poor man's friend.

Gas is an institution of the utmost value to the artisan; it requires hardly any attention, is supplied upon regulated terms, and gives with what should be a cheerful light a genial warmth, which often saves the lighting of a fire. The time is moreover not far distant, I venture to think, when both rich and poor will largely resort to gas as the most convenient, the cleanest, and the cheapest of heating agents, and when raw coal will be seen only at the colliery or the gasworks. In all cases where the town to be supplied is within say 30 miles of the colliery, the gasworks may with advantage be planted at the mouth, or still better at the bottom of the pit, whereby all haulage of fuel would be avoided, and the gas, in its ascent from the bottom of the colliery, would require an onward pressure sufficient probably to impel it to its destination. The possibility of transporting combustible gas through pipes for such a distance has been proved at Pittsburg, where natural gas from the oil districts is used in large quantities.

The quasi monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. The gas being supplied by meter, it has been seemingly to the advantage of the companies to give merely the prescribed illuminating power, and to discourage the invention of economical burners, in order that the consumption might

reach a maximum. The application of gas for heating purposes has not been encouraged, and is still made difficult in consequence of the objectionable practice of reducing the pressure in the mains during daytime to the lowest possible point consistent with prevention of atmospheric indraught. The introduction of electric light has convinced gas managers and directors that such a policy is no longer tenable, but must give way to one of technical progress; new processes for cheapening the production and increasing the purity and illuminating power of gas are being fully discussed before the Gas Institute; and improved burners, rivalling the electric light in brilliancy, greet our eyes as we pass along our principal thoroughfares.

Regarding the importance of the gas supply as it exists at present, we find from a Government return that the capital invested in gasworks in England, other than those of local authorities, amounts to £30,000,000; in these 4,281,048 tons of coal are converted annually, producing 43,000 million cubic feet of gas, and about 2,800,000 tons of coke; whereas the total amount of coal annually converted in the United Kingdom may be estimated at 9,000,000 tons, and the by-products therefrom at 500,000 tons of tar, 1,000,000 tons of ammonia liquor, and 4,000,000 tons of coke, according to the returns kindly furnished me by the managers of many of the gasworks and corporations. To these may be added say 120,000 tons of sulphur, which up to the present time is a waste product.

Previous to the year 1856—that is to say, before Mr. W. H. Perkin had invented his practical process, based chiefly upon the theoretical investigations of Hofmann, regarding the coal-tar bases and the chemical constitution of indigo—the value of coal-tar in London was scarcely a halfpenny a gallon, and in country places gas makers were glad to give it away. Up to that time the coal-tar industry had consisted chiefly in separating the tar by distillation into naphtha, creosote, oils, and pitch. A few distillers, however, made small quantities of benzene, which had been first shown—by Mansfield, in 1849—to exist in coal-tar naphtha mixed with toluene, cumene, &c. The discovery, in 1856, of the mauve or aniline purple gave a great impetus to the coal-tar trade, inasmuch as it necessitated the separation of large quantities of benzene, or a mixture of benzene and toluene, from the naphtha. The trade was further increased by the discovery of the magenta or rosaniline dye, which required the same products for its preparation. In the meantime, carbolic acid was gradually introduced into commerce, chiefly as a disinfectant, but also for the production of colouring matter.

The colour industry utilises even now practically all the benzene, a large proportion of the solvent naphtha, all the anthracene, and a portion of the naphthalene resulting from the distillation of coal-tar; and the value of the colouring matter thus produced is estimated by Mr. Perkin at £3,350,000.

The demand for ammonia may be taken as unlimited, on account of its high agricultural value as a manure; and, considering the failing supply of guano and the growing necessity for stimulating the fertility of our soil, an increased production of ammonia may be regarded as a matter of national importance, for the supply of which we have to look almost exclusively to our gas-works. The present production of 1,000,000 tons of liquor yields 95,000 tons of sulphate of ammonia; which, taken at £20 10s. a ton, represents an annual value £1,947,000.

The total annual value of the gas-works by-products may be estimated as follows:—

Colouring matter	£3,350,000
Sulphate of ammonia	1,947,000
Pitch (325,000 tons)	365,000
Creosote (25,000,000 gallons)	208,000
Crude carbolic acid (1,000,000 galls.)	100,000
Gas coke, 4,000,000 tons (after allowing 2,000,000 consumption in working the retorts) at 12s. . .	2,400,000

£8,370,000

Taking the coal used, 9,000,000 tons, at 12s., equal £5,400,000, it follows that the by-products exceed in value the coal used by very nearly £3,000,000.

In using raw coal for heating purposes these valuable products are not only absolutely lost to us, but in their stead we are favoured with those semi-gaseous by-products in the atmosphere too well known to the denizens of London and other large towns as smoke. Prof. Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to fifty tons, and that the carbonic oxide, a poisonous compound, resulting from the imperfect combustion of coal, may be taken as at least five times that amount. Mr. Aitken has shown, moreover, in an interesting paper communicated to the Royal Society of Edinburgh last year, that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog; each particle of solid matter attracting to itself aqueous vapour; these globules of fog are rendered particularly tenacious and disagreeable by the presence of tar vapour, another result of imperfect combustion of raw fuel, which might be turned to much better account at the dye-works. The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel, are now being recognised, as is evinced by the success of recent Smoke Abatement Exhibitions. The most effectual remedy would result from a general recognition of the fact that wherever smoke is produced fuel is being consumed wastefully, and that all our calorific effects, from the largest down to the domestic fire, can be realised as completely, and more economically, without allowing any of the fuel employed to reach the atmosphere unburnt. This most desirable result may be effected by the use of gas for all heating purposes with or without the addition of coke or anthracite.

The cheapest form of gas is that obtained through the entire distillation of fuel in such gas producers as are now largely used in working the furnaces of glass, iron, and steel works; but gas of this description would not be available for the supply of towns owing to its bulk, about two-thirds of its volume being nitrogen. The use of water-gas, resulting from the decomposition of steam in passing through a hot chamber filled with coke, has been suggested, but this gas also is objectionable, because it contains, besides hydrogen, the poisonous and inodorous gas carbonic oxide, the introduction of which into dwelling-houses could not be effected without considerable danger. A more satisfactory mode of supplying heating separately from illuminating gas would consist in connecting the retort at different periods of the distillation with two separate systems of mains for the delivery of the respective gases. By resorting to improved means of heating the retorts with gaseous fuel, such as have been in use at the Paris gas-works for a considerable number of years, the length of time for effecting each distillation may be shortened from six hours, the usual period in former years, to four, or even three hours, as now practised at Glasgow and elsewhere. By this means a given number of retorts can be made to produce, in addition to the former quantity of illuminating gas of superior quality, a similar quantity of heating gas, resulting in a diminished cost of production, and an increased supply of the valuable by-products previously referred to.

The greater efficiency of gas as a fuel results chiefly from the circumstance that a pound of gas yields in combustion 22,000 heat units, or exactly double the heat produced in the combustion of a pound of ordinary coal. This extra heating power is due partly to the freedom of the gas from earthy constituents, but chiefly to the heat imparted to it in effecting its distillation. Recent experiments with gas-burners have shown that in this direction also there is much room for improvement.

The amount of light given out by a gas flame depends upon the temperature to which the particles of solid car-

bon in the flame are raised, and Dr. Tyndall has shown that of the radiant energy set up in such a flame, only the $\frac{1}{100}$ th part is luminous; the hot products of combustion carry off at least four times as much energy as is radiated, so that not more than one-hundredth part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air-current or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation; this limit may be fixed at about 2300° C., and cannot be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved, gas-lighting may continue its rivalry with electric lighting both as regards economy and brilliancy, and such rivalry must necessarily result in great public advantage.

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versa*, by means of the dynamo-electrical machine, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation, and these may be so completely avoided that Dr. Joule was able by this method to determine the equivalent values of the two forms of energy. But in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable.

In the condensing steam-engine this waste heat comprises that communicated to the condensing water, whilst the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120° C. except in the engines constructed by Mr. Perkins, in which a range of 160° C., or an expansive action commencing at 14 atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell. To obtain more advantageous primary conditions we have to turn to the calorific or gas-engine, because in them the coefficient of efficiency expressed by $\frac{T - T'}{T}$, may be greatly

increased. This value would reach a maximum if the initial absolute temperature T could be raised to that of combustion, and T' reduced to atmospheric temperature, and these maximum limits can be much more nearly approached in the gas-engine worked by a combustible mixture of air and hydrocarbons than in the steam-engine.

Before many years have elapsed we shall find in our factories and on board our ships engines with a fuel consumption not exceeding 1 pound of coal per effective horsepower per hour, in which the gas producer takes the place of the somewhat complex and dangerous steam-boiler. The advent of such an engine and of the dynamo-machine must mark a new era of material progress at least equal to that produced by the introduction of steam power in the

early part of our century. Let us consider what would be the probable effect of such an engine upon that most important interest of this country—the merchant navy.

According to returns kindly furnished me by the Board of Trade and "Lloyds' Register of Shipping," the total value of the merchant shipping of the United Kingdom may be estimated at £126,000,000, of which £90,000,000 represent steamers having a net tonnage 3,003,988 tons; and £36,000,000 sailing vessels, of 3,688,008 tons. The safety of this vast amount of shipping, carrying about five-sevenths of our total imports and exports, or £500,000,000 of goods in the year, and of the more precious lives connected with it, is a question of paramount importance. It involves considerations of the most varied kind: comprising the construction of the vessel itself, and the material employed in building it; its furniture of engines, pumps, sails, tackle, compass, sextant, and sounding apparatus, the preparation of reliable charts for the guidance of the navigator, and the construction of harbours of refuge, lighthouses, beacons, bells, and buoys, for channel navigation. Yet notwithstanding the combined efforts of science, inventive skill, and practical experience—the accumulation of centuries—we are startled with statements to the effect that during last year as many as 1007 British-owned ships were lost, of which fully two-thirds were wrecked upon our shores, representing a total value of nearly £10,000,000. Of these ships 870 were sailing vessels and 137 steamers, the loss of the latter being in a fourth of the cases attributable to collision. The number of sailing vessels included in these returns being 19,325, and of steamers 5505; it appears that the steamer is the safer vessel, in the proportion of 4·43 to 3·46; but the steamer makes on an average three voyages for one of the sailing-ship taken over the year, which reduces the relative risk of the steamer as compared with the sailing-ship per voyage in the proportion of 13·29 to 3·46. Commercially speaking, this factor of safety in favour of steam-shiping is to a great extent counterbalanced by the value of the steamship, which bears to that of the sailing-vessel per net carrying ton the proportion of 3:1, thus reducing the ratio in favour of steam shiping as 13·29 to 10·38, or in round numbers as 4:3.

In considering the question how the advantages thus established in favour of steam-shiping could be further improved, attention should be called in the first place to the material employed in their construction. A new material was introduced for this purpose by the Admiralty in 1876-78, when they constructed at Pembroke dockyard the two steam corvettes, the *Iris* and *Mercury*, of mild steel. The peculiar qualities of this material are such as to have enabled shipbuilders to save 20 per cent in the weight of the ship's hull, and to increase to that extent its carrying capacity. It combines with a strength 30 per cent superior to that of iron such extreme toughness that in the case of collision the side of the vessel has been found to yield or bulge several feet without showing any signs of rupture, a quality affecting the question of sea risk very favourably. When to the use of this material there are added the advantages derived from a double bottom, and from the division of the ship's hold by means of bulk-heads of solid construction, it is difficult to conceive how such a vessel could perish by collision either with another vessel or with a sunken rock. The spaces between the two bottoms are not lost, because they form convenient chambers for water ballast, but powerful pumps should in all cases be added to meet emergencies.

If to the improvements already achieved could be added an engine of half the weight of the present steam-engine and boilers, and working with only half the present expenditure of fuel, a further addition of 30 per cent could be made to the cargo of an Atlantic propeller vessel—no longer to be called a steamer—and the balance of advantages in favour of such vessels would be sufficient to restrict the use of sailing craft chiefly to the regattas of this and neighbouring ports.

The admirable work on the "British Navy," lately published by Sir Thomas Brassey, the Civil Chief Lord of the Admiralty, shows that the naval department of this country is fully alive to all improvements having regard to the safety as well as the fighting qualities of Her Majesty's ships of war, and recent experience goes far to prove that although high speed and manœuvring qualities are of the utmost value, the armour plate which appeared to be fast sinking in public favour is not without its value in actual warfare.

The progressive views perceptible in the construction of the navy are further evidenced in a remarkable degree in the hydrographic department. Captain Sir Frederick Evans, the hydrographer, and Vice-President of the British Association, gave us at York last year a very interesting account of the progress made in that department, which, while dealing chiefly with the preparation of charts showing the depth of water, the direction and force of currents, and the rise of tides near our shores, contains also valuable statistical information regarding the more general questions of the physical conditions of the sea, its temperature at various depths, its flora and fauna, as also the rainfall and the nature and force of prevailing winds. In connection with this subject the American Naval Department has taken an important part, under the guidance of Captain Maury and the Agassiz father and son, whilst in this country the persistent labours of Dr. William Carpenter deserve the highest consideration.

Our knowledge of tidal action has received a most powerful impulse through the invention of a self-recording gauge and tide-predictor, which will form the subject of one of the discourses to be delivered at our present meeting by its principal originator, Sir William Thomson.

The application of iron and steel in naval construction rendered the use of the compass for some time illusory, but in 1839 Sir George Airy showed how the errors of the compass, due to the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighbourhood of the binnacle, but the great size of the needles in the ordinary compasses rendered the correction of the quadrantal errors practically unattainable. In 1876 Sir William Thomson invented a compass with much smaller needles than those previously used, which allows Sir George Airy's principle to be applied completely.

Sir William Thomson has also enriched the art of navigation by the invention of two sounding machines; the one being devised for ascertaining great depths very accurately in less than one-quarter the time formerly necessary, and the other for taking depths up to 130 fathoms without stopping the ship in its onward course. In both these instruments steel pianoforte wire is used instead of the hempen and silken lines formerly employed; in the latter machine the record of depth is obtained not by the quantity of wire run over its counter and brake wheel, but through the indications produced upon a simple pressure gauge consisting of an inverted glass tube, whose internal surface is covered beforehand with a preparation of chromate of silver, rendered colourless by the sea-water up to the height to which it penetrates. The value of this instrument for guiding the navigator within what he calls "soundings" can hardly be exaggerated; with the sounding machine and a good chart he can generally make out his position correctly by a succession of three or four casts in a given direction at given intervals, and thus in foggy weather is made independent of astronomical observations and of the sight of lighthouses or the shore. By the proper use of this apparatus, such accidents as happened to the mail steamer *Mosel* not a fortnight ago would not be possible. As regards the value of the deep-sea instrument I can speak from personal experience, as on one occasion it enabled those in charge of the Cable s.s. *Faraday* to find the end of an Atlantic Cable, which had parted in a gale of wind, with no other indication of the locality than a single sounding, giving a depth of 950 fathoms. To recover the cable a number of soundings

in the supposed neighbourhood of the broken end were taken, the 950 fathom contour line was then traced upon a chart, and the vessel thereupon trailed its grapnel two miles to the eastward of this line, when it soon engaged the cable 20 miles away from the point, where dead reckoning had placed the ruptured end.

The time allowed me for addressing you on this occasion is wholly insufficient to do justice to the great engineering works of the present day, and I must therefore limit myself to making a short allusion to a few only of the more remarkable enterprises.

The great success, both technically and commercially, of the Suez Canal has stimulated M. de Lesseps to undertake a similar work of even more gigantic proportions, namely, the piercing of the Isthmus of Panama by a ship canal, 40 miles long, 50 yards wide on the surface, and 20 yards at the bottom, upon a dead level from sea to sea. The estimated cost of this work is £20,000,000; and more than this sum having been subscribed, it appears unlikely that political or climatic difficulties will stop M. de Lesseps in its speedy accomplishment. Through it China, Japan, and the whole of the Pacific Ocean, will be brought to half their present distance, as measured by the length of voyage, and an impulse to navigation and to progress will thus be given which it will be difficult to over-estimate.

Side by side with this gigantic work, Captain Eads, the successful improver of the Mississippi navigation, intends to erect his ship railway, to take the largest vessels, fully laden and equipped, from sea to sea, over a gigantic railway across the Isthmus of Tehuantepec, a distance of 95 miles. Mr. Barnaby, the chief constructor of the navy, and Mr. John Fowler have expressed a favourable opinion regarding this enterprise, and it is to be hoped that both the canal and the ship railway will be accomplished, as it may be safely anticipated that the traffic will be amply sufficient to support both these undertakings.

Whether or not M. de Lesseps will be successful also in carrying into effect the third great enterprise with which his name has been prominently connected, the flooding of the Tunis-Algerian Chotts, thereby re-establishing the Lake Tritonis of the ancients, with its verdure-clad shores, is a question which could only be decided upon the evidence of accurate surveys, but the beneficial influence of a large sheet of water within the African desert could hardly be matter of doubt.

It is with a feeling not unminged with regret that I have to record the completion of a new Eddystone Lighthouse in substitution for the *chef-d'œuvre* of engineering erected by John Smeaton more than 100 years ago. The condemnation of that structure was not, however, the consequence of any fault of construction, but was caused by inroads of the sea upon the rock supporting it. The new lighthouse, designed and executed by Mr., now Sir, James Douglass, engineer of Trinity House, has been erected in the incredibly short time of less than two years, and bids fair to be worthy of its famed predecessor. Its height above high water is 130 feet, as compared with 72 feet, the height of Telford's structure, which gives its powerful light a considerably increased range. The system originally suggested by Sir William Thomson, some years ago, of distinguishing one light from another by flashes following at varied intervals, has been adopted by the Elder Brethren in this as in other recent lights in the modified form introduced by Dr. John Hopkinson, in which the principle is applied to revolving lights, so as to obtain a greater amount of light in the flash.

The geological difficulties which for some time threatened the accomplishment of the St. Gothard Tunnel have been happily overcome, and this second and most important sub-Alpine thoroughfare now connects the Italian railway system with that of Switzerland and the south of Germany, whereby Genoa will be constituted the shipping port for those parts.

Whether we shall be able to connect the English with

the French railway system by means of a tunnel below the English Channel is a question that appears dependent at this moment rather upon military and political than technical and financial considerations. The occurrence of a stratum of impervious grey chalk, at a convenient depth below the bed of the Channel, minimises the engineering difficulties in the way, and must influence the financial question involved. The protest lately raised against its accomplishment can hardly be looked upon as a public verdict, but seems to be the result of a natural desire to pause pending the institution of careful inquiries. These inquiries have been made by a Royal scientific Commission, and will be referred for further consideration to a mixed Parliamentary Committee, upon whose Report it must depend whether the natural spirit of commercial enterprise has to yield in this instance to political and military considerations. Whether the Channel Tunnel is constructed or not, the plan proposed some years ago by Mr. John Fowler of connecting England and France by means of a ferry-boat capable of taking railway trains would be a desideratum justified by the ever-increasing intercommunication between this and Continental countries.

The public inconvenience arising through the obstruction to traffic by a sheet of water is well illustrated by the circumstance that both the estuaries of the Severn and of the Mersey are being undermined in order to connect the railway systems on the two sides, and that the Frith of Forth is about to be spanned by a bridge exceeding in grandeur anything as yet attempted by the engineer. The roadway of this bridge will stand 150 feet above high-water mark, and its two principal spans will measure a third of a statute mile each. Messrs. Fowler and Baker, the engineers to whom this great work has been entrusted, could hardly have accomplished their task without having recourse to steel for their material of construction, nor need the steel used be of the extra mild quality particularly applicable for naval structures to withstand collision, for, when such extreme toughness is not required, steel of very homogeneous quality can be produced, bearing a tensile strain double that of iron.

When the British Association met at Southampton on a former occasion, Schönbein announced to the world his discovery of gun-cotton. This discovery has led the way to many valuable researches on explosives generally, in which Mr. Abel has taken a leading part. Recent investigations by him, in connection with Captain Noble, upon the explosive action of gun-cotton and gunpowder confined in a strong chamber, which have not yet been published, deserve particular attention. They show that while by the method of investigation pursued about twenty years ago by Karoyle (of exploding gunpowder in very small charges in shells confined within a large shell partially exhausted of air), the composition of the gaseous products was found to be complicated and liable to variation, the chemical metamorphosis which gun-cotton sustains, when exploded under conditions such as obtain in its practical application, is simple and very uniform. Among other interesting points noticed in this direction was the fact that, as in the case of gunpowder, the proportion of carbonic acid increases, while that of carbonic oxide diminishes with the density of the charge.

Messrs. Noble and Abel are also continuing their researches upon fired gunpowder, being at present occupied with an inquiry into the influence exerted upon the chemical metamorphosis and ballistic effects of fired gunpowder by variation in its composition, their attention being directed especially to the discovery of the cause of the more or less considerable erosion of the interior surface of guns produced by the exploding charge—an effect which, notwithstanding the application of devices in the building up of the charge specially directed to the preservation of the gun's bore, have become so serious that, with the enormous charges now used in our heavy guns, the erosive action on the surface of the bore produced by a single round is distinctly perceptible. As there appeared

to be *primâ facie* reasons why the erosive action of powder upon the surface of the bore at the high temperatures developed should be at any rate in part due to its one component sulphur, Noble and Abel have made comparative experiments with powders of usual composition and with others in which the proportion of sulphur was considerably increased, the extent of erosive action of the products escaping from the explosion vessel under high tension being carefully determined. With small charges a particular powder containing no sulphur was found to exert very little erosive action as compared with ordinary cannon powder; but another powder, containing the maximum proportion of sulphur tried (15 per cent), was found equal to it under these conditions, and exerted very decidedly less erosive action than it, when larger charges were reached. Other important contributions to our knowledge of the action of fired gunpowder in guns, as well as decided improvements in the gunpowder manufactured for the very heavy ordnance of the present day, may be expected to result from a continuance of these investigations. Prof. Carl Himly, of Kiel, having been engaged upon investigations of a similar nature, has lately proposed a gunpowder in which hydrocarbons precipitated from solution in naphtha take the place of the charcoal and sulphur of ordinary powder; this powder has, amongst others, the peculiar property of completely resisting the action of water, so that the old caution "Keep your powder dry" may hereafter be unnecessary.

The extraordinary difference of condition, before and after its ignition, of such matter as constitutes an explosive agent, leads up to a consideration of the aggregate state of matter under other circumstances. As early as 1776 Alexander Volta observed that the volume of glass was changed under the influence of electrification, by what he termed electrical pressure. Dr. Kerr, Govi, and others have followed up the same inquiry, which is at present continued chiefly by Dr. George Quincke, of Heidelberg, who finds that temperature, as well as chemical constitution of the dielectric under examination, exercises a determining influence upon the amount and character of the change of volume effected by electrification; that the change of volume may under certain circumstances be effected instantaneously as in flint glass, or only slowly as in crown glass, and that the elastic limit of both is diminished by electrification, whereas in the case of mica and of gutta-percha an increase of elasticity takes place.

Still greater strides are being made at the present time towards a clearer perception of the condition of matter when particles are left some liberty to obey individually the forces brought to bear upon them. By the discharge of high tension electricity through tubes containing highly rarefied gases (Geissler's tubes), phenomena of discharge were produced which were at once most striking and suggestive. The Sprengel pump afforded a means of pushing the exhaustion to limits which had formerly been scarcely reached by the imagination. At each step the condition of attenuated matter revealed varying properties when acted upon by electrical discharge and magnetic force. The radiometer of Crookes imported a new feature into these inquiries, which at the present time occupy the attention of leading physicists in all countries.

The means usually employed to produce electrical discharge in vacuum tubes was Ruhmkorff's coil; but Mr. Gassiot first succeeded in obtaining the phenomena by means of a galvanic battery of 3000 Leclanché cells. Dr. De la Rue, in conjunction with his friend, Dr. Hugo Müller, has gone far beyond his predecessors in the production of batteries of high potential. At his lecture "On the Phenomena of Electric Discharge," delivered at the Royal Institution in January, 1881, he employed a battery of his invention consisting of 14,400 cells (14,832 Volts), which gave a current of 0.054 Ampère, and produced a discharge at a distance of 0.71 inch between the terminals. During last year he increased the number of cells to 15,000 (15,450 Volts), and increased the current

to 0.4 Ampère, or eight times that of the battery he used at the Royal Institution.

On the occasion of his lecture, Dr. De la Rue produced, in a very large vacuum tube, an imitation of the Aurora Borealis; and he has deduced from his experiments that the greatest brilliancy of Aurora displays must be at an altitude of from 37 to 38 miles—a conclusion of the highest interest, and in opposition to the extravagant estimate of 281 miles at which it had been previously put.

The President of the Royal Society has made the phenomena of electrical discharge his study for several years, and resorted in his important experiments to a special source of electric power. In a note addressed to me, Dr. Spottiswoode describes the nature of his investigations much more clearly than I could venture to give them. He says: "It had long been my opinion that the dissymmetry shown in electrical discharges through rarefied gases must be an essential element of every disruptive discharge, and that the phenomena of stratification might be regarded as magnified images of features always present, but concealed under ordinary circumstances. It was with a view to the study of this question that the researches by Moulton and myself were undertaken. The method chiefly used consisted in introducing into the circuit intermittence of a particular kind, whereby one luminous discharge was rendered sensitive to the approach of a conductor outside the tube. The application of this method enabled us to produce artificially a variety of phenomena, including that of stratification. We were thus led to a series of conclusions relating to the mechanism of the discharge, among which the following may be mentioned:—

"1. That a stria, with its attendant dark space, forms a physical unit of a striated discharge.

"2. That the origin of the luminous column is to be sought for at its negative end; that the luminosity is an expression of a demand for negative electricity.

"3. That the time occupied by electricity of either name in traversing a tube is greater than that occupied in traversing an equal length of wire, but less than that occupied by molecular streams (Crookes's radiations) in traversing the tubes.

"4. That the brilliancy of the light with so little heat may be due in part to brevity in the duration of the discharge.

"5. That striæ are not merely loci in which electrical is converted into luminous energy, but are actual aggregations of matter.

"This last conclusion was based mainly upon experiments made with an induction coil excited in a new way,—viz., directly by an alternating machine, without the intervention of a commutator or condenser. This mode of excitement promises to be one of great importance in spectroscopic work, as well as in the study of the discharge in a magnetic field, partly on account of the simplification which it permits in the construction of induction coils, but mainly on account of the very great increase of strength in the secondary currents to which it gives rise."

These investigations assume additional importance when we view them in connection with solar—I may even say stellar—physics, for evidence is augmenting in favour of the view that interstellar space is not empty, but is filled with highly attenuated matter of a nature such as may be put into our vacuum tubes. Nor can the matter occupying stellar space be said any longer to be beyond our reach for chemical and physical test. The spectro-scope has already thrown a flood of light upon the chemical constitution and physical condition of the sun, the stars, the comets, and the far distant nebulae, which have yielded spectroscopic photographs under the skilful management of Dr. Huggins, and Dr. Draper, of New York. Armed with greatly improved apparatus the physical astronomer has been able to reap a rich harvest of scientific information during the short periods of the last two solar eclipses; that of 1879, visible in America, and that of May last, observed in Egypt by Lockyer

Schuster, and by Continental observers of high standing. The result of this last eclipse expedition has been summed up as follows: "Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydrocarbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz. :—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.
2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.
3. That the effect of solar rotation is to draw in dissociated vapours upon the polar surfaces, and to eject them after combustion has taken place back into space equatorially.

It is therefore a matter of peculiar gratification to me that the results of observation here recorded give considerable support to that speculation. The luminous equatorial extensions of the sun which the American observations revealed in such a striking manner (with which I was not acquainted when writing my paper), were absent in Egypt; but the outflowing equatorial streams I suppose to exist could only be rendered visible by reflected sunlight, when mixed with dust produced by exceptional solar disturbances or by electric discharge; and the occasional appearance of such luminous extensions would serve only to disprove the hypothesis entertained by some, that they are divided planetary matter, in which case their appearance should be permanent. Professor Langley, of Pittsburg, has shown by means of his Bolometer, that the solar actinic rays are absorbed chiefly in the solar instead of in the terrestrial atmosphere, and Captain Abney has found by this new photometric method that absorption due to hydrocarbons takes place somewhere between the solar and the terrestrial atmosphere; in order to test this interesting result still further, he has lately taken his apparatus to the top of the Riffl with a view of diminishing the amount of terrestrial atmospheric air between it and the sun, and intends to bring a paper on this subject before Section A. Stellar space filled with such matter as hydro-carbon and aqueous vapour would establish a material continuity between the sun and his planets, and between the innumerable solar systems of which the universe is composed. If chemical action and reaction can further be admitted, we may be able to trace certain conditions of thermal dependence and maintenance, in which we may recognise principles of high perfection, applicable also to comparatively humble purposes of human life.

We shall thus find that in the great workshop of nature there are no lines of demarcation to be drawn between the most exalted speculation and common-place practice, and that all knowledge must lead up to one great result, that of an intelligent recognition of the Creator through His works. So then, we members of the British Association and fellow-workers in every branch of science may exhort one another in the words of the American bard who has so lately departed from amongst us :—

Let us then be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labour and to wait.

Salicylic Acid in Violets.—Prof. Maudelin maintains that *Viola syrtica*, *V. tricolor*, and *V. arvensis*, contain from 0.083 to 0.144 per ct. of salicylic acid.—*Cosmos les Mondes*.

THE HUDDERSFIELD LEAD-POISONING CASE.

An action for damages for injury resulting from the use of a public water-supply has recently been decided at the Yorkshire Summer Assizes. As the case appears to have escaped the Metropolitan journals, and as, in addition to its strictly scientific bearings, it must prove instructive to all interested in the supply of water to towns, we shall notice its principal features at some length.

The facts of the case were these :—Mr. J. J. Milnes, a solicitor practising at Huddersfield, and living at Long Lane, Dalton, in the outskirts of that town, was attacked about a year ago, first with violent colic, and ultimately with wrist-drop, and the other usual symptoms of lead-poisoning. He lost almost entirely the use of his arms, his brain was affected, and at one time his life seemed in peril. He has, subsequently, under able medical treatment, partially recovered the use of his limbs, but is said to be still unable, *e.g.*, to dress himself. The fact that the patient was suffering from lead-poisoning being beyond all dispute, the question arose as to how the noxious metal was introduced into his system. It appears that the water-supply, which, as in most towns of the north of England, is the property of the Corporation, is derived from several reservoirs, Mr. Milne's house being served from the so-called "Blackmoorfoot" reservoir. All the various water-sources are remarkably free, both from organic and mineral impurities, and are consequently exceedingly soft,—that from the Blackmoorfoot dam being perhaps the purest. Unfortunately, in virtue of that very purity, it is, though perfectly wholesome in the reservoirs, channels, and mains, capable of acting upon lead service-pipes. Concerning the immediate cause and *modus operandi* of this action differences of opinion prevail, to which we may advert below. But in samples of water drawn in the plaintiff's house, Mr. Jarman, borough analyst for Huddersfield, found lead to the amount of 0.34 grain per gallon; Mr. Fairley, the Leeds public analyst, gave the quantity of lead as 0.4 grain, whilst Mr. A. Allen, the analyst for Sheffield, found in two samples respectively 0.77 and 0.84 grain of lead per gallon. On the other hand, Dr. Tidy found in a sample of water from the plaintiff's kitchen, only 0.01, and in that from his wash-house 0.04 grain per gallon. These discrepancies are quite intelligible without casting any reflection upon the accuracy of the chemists above named. The contamination of lead being derived from the service-pipes which the water traversed on its way from the mains, it is plain that different samples must vary largely according to the time the water had been allowed to stand in them before being drawn. We do not in the least doubt that a sample taken early in the morning might contain the proportion of lead as given by Mr. Allen. It is a wise precaution in all cases where a soft water has to traverse lead pipes to let it flow for some minutes in the morning, so as to empty the pipes, before taking any for culinary uses.

We now come to the important point : Does the water of the Blackmoorfoot dam dissolve lead more rapidly than soft waters generally, and if so, wherefore? Mr. Jarman, in an official report given in to the Corporation as it appears in 1879, states that the Blackmoorfoot water very closely resembles that supplied by the Manchester Corporation. Indeed, the waters of Halifax, Bradford, Leeds, Batley, Sheffield, and Manchester, as well as that from most of the Huddersfield reservoirs, if allowed to lodge in a lead pipe for twelve hours, all took up appreciable quantities of the metal. Dr. Robertson is even reported to have said that the Manchester water has been found to contain 0.3 grain of the poisonous metal per gallon. Hence we must conclude that the Blackmoorfoot water does not form any marked exception to other mountain waters.

It may, of course, be asked why, if lead be so generally present, or liable to be present in pipe-waters, is painter's

colic not more common? In reply, we may refer to the testimony of the medical witnesses that such cases are not rare, and that lead is exceedingly capricious in its action. A man's power of resisting lead, or, indeed, many other poisons, stands in no perceptible relation to his apparent health and vigour.

As regards the solvent action of the water in question it was admitted to have an acid reaction. This was due to the presence of sulphuric acid, as was shown by Dr. Tidy. Here there arose a difference of opinion: Dr. Tidy, Prof. Odling, and Mr. Crookes were of opinion that sulphuric acid, if present in small quantities, must tend to protect the pipes from the action of the water, a thin layer of the insoluble, or at least very sparingly soluble, lead sulphate being formed. Mr. Allen took a different and, we must say, a novel view. He said that sulphuric acid would cause corrosion. He is reported as having said that he disagreed with the high scientific authorities who held that sulphuric acid neutralised the solvent effects of water. This point is of sufficient importance to require especial experimental examination. The origin of the sulphuric acid was supposed to be this: The Black-moorfoot dam receives certain ferruginous springs. The iron-salts thus introduced, on being diffused in the water and exposed to air, become split up into a basic salt, which is deposited, and free acid, or rather, perhaps, an acid salt, which remains in solution. As a remedy, Mr. Jarman had recommended the addition of lime-water. But Dr. Tidy pointed out that this expedient was not free from risk, as, if the quantities of lime and acid were not nicely proportioned, the mischief might be increased. An opinion was expressed which is, we believe, gaining ground in explanation of the frequent action of soft pure waters upon boiler plates, *e.g.*, at Glasgow, viz., that the agency of corrosion is the oxygen held in solution in the water. If this is proved to be the case, its prevention will be very difficult, since a thorough de-aërating of the water, even if practicable, would cause it to be disliked, by many persons, as flat and insipid.

This question, the action of soft waters upon lead pipes, becomes weighty, in view of the proposals made to supply London with soft mountain water from Wales or Cumberland.

A material for service-pipes free from the objections which attach to lead is a desideratum. Block-tin is too costly; alloys of lead and tin are as objectionable as pure lead; iron is too inflexible, and gutta-percha, which was at one time recommended, has failed to give satisfaction.

ON A NOVEL APPLICATION OF ELECTROLYSIS IN DYEING AND PRINTING.

By M. F. GOPPELSRØEDER.

SINCE his former communications on the electrolytic formation of colouring matters the author has obtained further results.

1. To produce aniline-black upon cloth or paper he saturates them with an aqueous solution of a salt of aniline, preferably the hydrochlorate. He places them upon a plate of metal not capable of being attacked by the solution, and in contact with one of the poles of a galvanic battery or a small dynamo-electric machine. He places upon the cloth or paper a second metallic plate, which bears in relief the design to be produced, and which is in contact with the other pole. On giving the necessary pressure and causing the current to pass, a copy of the design is obtained in black. He has also in this manner reproduced medals and coins. Further, it is easy to write with a pencil of a metal which is not attacked or of con-

ductive carbon, forming one of the poles, upon the tissue or paper saturated with the solution of aniline salt, and laid upon a metal plate which forms the other pole. Wherever the pencil, lightly pressed, touches the material the current passes, and there is a development of black, which is fixed upon the fibre with the same solidity as blacks produced by the ordinary methods. This method may be employed in manufacturing establishments for marking pieces with a solid colour, black or otherwise, capable of resisting the operations of bleaching, dyeing, and printing. The author has confined himself to speak of the formation and simultaneous fixation of aniline-black, but his method applies to every other colouring-matter capable of being as readily formed by oxidation or dehydrogenation, and of being fixed upon tissues.

2. The same method of operation may serve for the discharge of colours fixed upon cloth, *e.g.*, Turkey-red or indigo-blue. The dyed pieces are saturated with a solution of nitrates, such as saltpetre, or chlorides, such as sodium and aluminium chlorides. At the positive pole there is produced nitric acid or chlorine, which attacks the colour, changing it into colourless oxidation-products, so that the parts of the cloth in contact with the relief of the second plate becomes decolourised. We obtain thus a white discharge on a red, blue, &c., ground. By selecting salts whose bases may play the part of mordants, we may thus, by a dye-bath, produce new colours at the discharged parts. It is also possible that certain oxides set free by the action of the current, of the higher oxides and colours formed by the same action, may fix themselves upon the cloth and impart to it their colour. The author hopes soon to make known the reactions of the various salts in presence of the fibres under the influence of the current, as well as of the colours and mordants to which they may give rise. But there is still another manner of discharging, forming, and fixing colours simultaneously. If we saturate tissues (Turkey-red or indigo-blue) with aniline hydrochlorate, there will be on passing the current, not merely discharge of the colour, but at the same time formation of aniline-black.

3. There are also cases where the negative electrode plays the principal part. The oxidation of colours during printing may be prevented by plunging the negative electrode of a battery or of a small dynamo-electric machine into the colour-trough which contains the colour to be printed on, and placing the contents of this principal trough in communication with a very small secondary trough, which contains either the same colour or any liquid conductor, into which is plunged the positive electrode. The communication is made either by a septum of parchment-paper, or of porous clay, or by a tube. The hydrogen is evolved at the negative pole in the midst of the colour to be printed, and hinders oxidation. It is possible to precipitate upon the fibres heavy or precious metals. It is merely necessary to impregnate the cloth with a solution, properly thickened, of a salt of any of these metals, and to let the negative electrode act in order to precipitate the metal upon the fibre.

4. The current may also be used for preparing vats of indigo, aniline-black, &c., utilising the hydrogen which is liberated at the negative pole. The colour is thus reduced as effectually as by the ordinary methods. When such vats are prepared their oxidation may be prevented by causing the negative electrode of a feeble continuous current to act upon them. A separation, as perfect as possible, of the two electrodes is required, which will not present any difficulties.—*Comptes Rendus.*

Existence of "Azobihydre" (H_2N).—E. Maumené. —The author calls in question the accuracy of the conclusions of MM. Wurtz and Combes, who have not succeeded in verifying his results. He appends the remark that "modern chemistry is more than imperfect."—*Cosmos Les Mondes.*

Schuster, and by Continental observers of high standing. The result of this last eclipse expedition has been summed up as follows: "Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydrocarbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz. :—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.
2. That these gaseous compounds are cap dissociated by radiant solar energy while extreme attenuation.
3. That the effect of solar rotation dissociated vapours upon the polar surface after combustion has taken place equatorially.

It is therefore a matter of fact that the results of observations made in the equatorial extensions of the Nile, which is often the source of a water and the source of a considerable or large quantity, of the conditions of the Nile, reduced on the large scale to a single organic matter. The coincidence of the results is always observable, nitrites and nitrate are not largely in some cases without exception, and in other instances (as Nos. 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891,

4. The general series of analyses of the dissolved gases confirms what has been said on previous pages of the general report as to the number of varying conditions which influence the results in this direction—oxidisability of organic matter present, temperature, extent of exposure

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† It is true that Dr. Smart took no very special pains with these determinations, which were looked upon merely as incidental to the main object, checking to some extent the information as to the general character of each water. Still, this part of the work was done with fully average ordinary care.

1 "Water Analysis," pp. 28 and 42.

THE HUDDERSFIELD ^{change with it in both}
^{agents. In a number of cases}

An action for damage from the carbon of organic public water-supply, but the extent to which this Yorkshire Summons varies greatly, and is masked by escaped the greater or less extent of the latter gas and its strictly from the air of the former. The conclusion to all in and Zeitel, from a few experiments, that the notice of free oxygen in solution does not bear any ratio to the quantity of acidified permanganate decolourised by a water, is sustained by many of the specimens in the main series, as for instance Nos. 60 to 80, inclusive. Nevertheless, it may be well to include an examination of the dissolved gases in the study of any water in regard to which the fullest chemical information is desired. In such a case the examination ought to be made with the least possible interval of time after collection of the sample, and preferably on the spot where the sample is taken, with observation of the temperature of water and air.

MICROSCOPICAL AND PATHOLOGICAL RESULTS.

Feeling my own incompetence properly to discuss these, I prefer to leave them to speak for themselves, except so far as Professor Martin has, as quoted in a previous part of the general report, given his views as to the methods employed and the general significance of the facts recorded—these views having been formed, however, while he still was ignorant of the history of the individual waters.

It may be said, I think, that the microscopic and culture observations indicate at the same time the real importance of connecting with a chemical examination of water a study in competent hands of its microscopic organisms, both as to number and kind, and also the difficulty often presented either by the sparseness or more frequently the abundance of these organisms, in fairly estimating their average relation to the mass of water. This difficulty is super-added, of course, to the imperfection of our knowledge as to the effects upon human health of some closely allied—even hardly distinguishable—organisms, of dangerous and harmless associations, and of perhaps the same organism in different stages of its life history. The probable general significance of certain large classes of organised forms seems, however, well established, and well worthy of attention.

It may also be said of the pathological experiments with rabbits, that, opening up as they do a new and almost untried field of research, they show the great complexity of conditions to be encountered, the necessity of careful attention to details, and of multiplying and varying such experiments as far as possible, and the caution which must be exercised in drawing generalised conclusions from them; but on the other hand the results so far obtained, many of which individually are exceedingly suggestive, seem to indicate that real value attaches to this method of investigation, not in the direction proposed by Emmerich (as a part of the ordinary examination of a drinking water, in order to determine directly its wholesomeness or the reverse), but as the means in part of arriving at trustworthy grounds for the interpretation of chemical and microscopical results.

SANITARY CONCLUSIONS AND INTERPRETATION OF RESULTS.

To admit of easier comparison the results by the chief processes examined have been thrown into graphical form in Tables XIX. and XX., of which the former refers to the natural waters and the latter to those artificially prepared. (These Tables will appear with the general report.)

Chemical Results contrasted with Actual Sanitary History of the Natural Waters examined.

1. An inspection of Table XIX. shows that *no strongly marked generic difference is presented by the results from*

* *Zeitschr. f. phys. Chem.* 5: 10 (1880).

any of the processes for the estimation of organic matter or its elements between the generally wholesome waters of Class I. and the medically condemned and fairly assumed as pernicious waters of Class II. Judging by the general impression of the curves upon the eye, one would be inclined to attribute somewhat more importance to the results involving nitrogen than to those dependent upon carbon, neither will afford the means of broadly distinguishing the two classes. This conclusion is otherwise illustrated by the figures in Table XXI.

TABLE XXI.—Comparison of Chemical results for Waters of Classes I. and II.

	Least Result.		Greatest Result.		Average.	
	Class I.	Class II.	Class I.	Class II.	Class I.	Class II.
n—	0.36	0.33	7.20	7.79	2.36	2.08
nitrogen—	0.08	0.03	1.41	0.68	0.56	1.04
Sum of organic carbon and nitrogen—	0.44	0.61	7.86	18.31	2.92	12.92
Nitrogen of free ammonia—	0.008	0.008	0.675	0.295	0.092	0.090
Nitrogen of albumenoid ammonia—	0.016	0.021	0.268	0.214	0.112	0.099
Nitrogen of total ammonia—	0.028	0.033	0.704	0.343	0.204	0.189
Oxygen consumed in one hour (Tidy)—	0.062	0.082	4.008	3.340	0.995	0.791
Oxygen consumed in three hours (Tidy)—	0.210	0.104	5.212	4.188	1.305	1.065
Oxygen consumed (Kubel)—	None	None	7.443	6.000	2.140	1.271

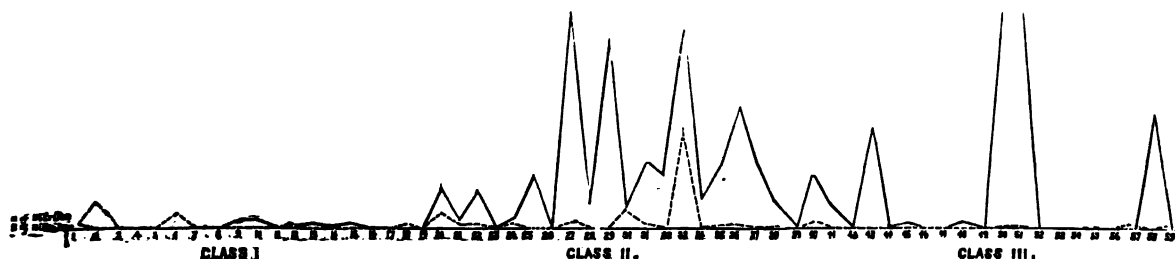
It will be seen from this table that no marked difference exists between the highest, lowest, or average result

assumption that some of the chemical products of the decomposition of organic matter are poisonous or noxious in their effect upon the human system. Thus, if the whole of the organic carbon and nitrogen found in such waters as Nos. 35 and 36, of the highly dangerous character of which there can scarcely be a doubt, existed as strychnine, it would be necessary to drink about half a gallon of the water at once in order to swallow an average medicinal dose of the alkaloid. It is not easy to believe that the ptomaines, or any other chemical products of putrefactive change as yet observed, can possess an intensity of toxic power so very much greater than that of the most energetic of recognised poisons. While numerous facts go to support the belief that, not to the effect of any chemical substances (such effect necessarily standing in definite relation to their quantity), but to the presence of living organisms with their power of practically unlimited self-multiplication, we must in all probability look for an explanation of, most at any rate, of the mischief attributable to drinking water, it is of course possible that indirectly a large amount of organic matter in water may be more dangerous than a smaller quantity, as furnishing on a greater scale the suitable material and conditions for the development of noxious as well as harmless organisms.*

Whether variations in the mere quantity of organic matter, within such limits as occur in water at all likely to be used for drinking, are of much importance in this respect, i.e., as determinant of the presence or abundance of organisms, is a question which may be asked, and on it depends, I think, largely the utility of all attempts to determine or estimate the quantity of organic matter or its constituents as such.

3. A much more conspicuous difference between the waters of Classes I. and II. is presented by the results for nitrites and nitrates, as shown in Table XXII.

In this table a tenfold height is given to the ordinates



obtained by any of the processes for the waters of Class I. and the corresponding result for those of Class II. No one could, with these figures to guide him, refer a water of unknown origin to one or the other of the two classes on the evidence afforded by chemical analysis, using any or all of the processes in question. The more varied results presented in Class III. admit of being studied with some interest in connection with the history of the individual waters, but are not available for the main purpose of testing the chemical methods, as this class includes only waters the sanitary character of which in advance of examination was more or less doubtful—waters under suspicion only.

2. Making the most liberal allowance for the imperfection of the different processes for the estimation of organic matter or its constituents, it is well worthy of notice how very small is the absolute amount of organic matter indicated as present in many of the most dangerous waters, an amount so small as to furnish important evidence against any chemical theory of the production of disease from this source, any theory based on the simple

representing the nitrites, the smaller quantity in which they occur requiring this exaggeration.

Here we find a very obvious connection between the results of chemical examination and the known sanitary character of the several waters, the salts of nitrous and nitric acid being rather absent or present in but trifling amount in the waters of Class I., believed to be wholesome, almost universally present, and in many cases of large quantity, in the pernicious waters of Class II., and very variable as to presence and amount in waters grouped together under the doubtful head of Class III. No aspect in which I have compared together the good and bad natural waters has afforded so definite a result as this.

This result is worthy of special attention in view of the different opinions which have been expressed as to the sanitary significance of nitrites and nitrates in water. Thus, Wanklyn says:† "The nitrates and nitrites have been erroneously regarded as measuring the defilement of water." "In fine, presence or abundance of nitrates does not show defilement by means of sewage, and

* This figure is undoubtedly too high, in consequence of incomplete reduction of nitrites. The next highest is 2.36, and even this is probably higher than the truth for the same reason.

† Including the no doubt erroneous highest single figure.

* Tiemann and Preusse have suggested that a polluted water may more probably contain disease ferments than a pure one, but it should not be inferred that an impure water is necessarily pernicious. Quoted in CHEM. NEWS, January 16, 1880, 30, 31.

† J. A. Wanklyn, "Water Analysis," Lond., 1879 97, 98.

deficiency of nitrates does not show absence of defilement. Many excellent waters have been condemned as unwholesome on account of the nitrates contained by them; and it cannot too strongly be insisted upon that the nitrates afford no data of any value in judging of the organic quality of a water." Angus Smith says:*

"There are many interesting questions to be asked regarding nitrates. I am inclined to think that their presence shows that the most dangerous state of the organic matter is past. When they appear in any solution, the chief escape of putrid gas seems to have ceased; the water may, however, be still dangerous to use, and, of course, is revolting to the imagination." . . . † "Those nitrates, however, which do remain indicate that at least an equivalent of albuminous matter or sewage matter *did* exist."

Frankland clearly expresses his view‡ as to this evidence of "previous sewage contamination" thus:—

"Large quantities [of nitrates] convict water of previous pollution by organic matters of animal origin. They tell only of the contamination which is past; but by inference, they also declare the probable nature of the organic matter now present. . . . Whether or no the analyst should form an unfavourable opinion of the water from the amount of nitrates must depend upon the proportion of organic matter actually present, and on his confidence in the efficiency and uniform action of the purifying process."

As the basis of his determination of "previous sewage contamination" Frankland takes the sum of the nitrogen present as ammoniacal salts, nitrites, and nitrates, diminished by an allowance for the average amounts of these substances in rain-water; he therefore treats the significance of the ammonia as the same with that of the nitrites and nitrates, as evidence merely of the past presence of nitrogenous organic matter, of which a part *may* remain.

Griess has expressed a strong opinion§ as to the sanitary importance of detecting nitrates, and the unfitness of water for drinking purposes when containing them.

Ekin|| attaches very great importance to the presence of nitrates and nitrites. Thus he says:

"Waters which have undoubtedly given rise to typhoid fever have been found by the writer over and over again not to contain more than 0.05 part of albumenoid ammonia in 1,000,000, and which, notwithstanding their containing a large excess of nitrates, have been passed by analysts of undoubted ability as being fit for drinking purposes. The attention of the writer was particularly drawn to this in the case of a district where typhoid fever was hardly ever absent, and where the conditions were such as pointed exclusively to water as being the aggravating cause. . . . Samples were taken when the pollution was evident, and analysed. Two only were found to contain an excess of albumenoid ammonia, but all contained a large excess of nitrates. . . . The significance of an excess of nitrates has already been sufficiently dwelt upon, and we have seen that both upon *a priori* grounds and as the result of actual experience, their presence in abnormal quantity is objectionable. . . . When the amount [of nitrates] exceeds 0.5 or 0.6 part [per 100,000], it points significantly to dangerous pollution; . . . nitrogen as nitrites should be invariably absent from a good water. . . . This view of the importance to be attached to an abnormal quantity of nitrates has been formed in spite of a considerable predisposition to a contrary opinion, and has been literally forced upon the writer again and again by the investigation of cases which really leave no doubt in the matter."

(To be continued.)

* CHEMICAL NEWS, September 3, 1869; 113.

† CHEMICAL NEWS, June 25, 1869; 305.

‡ "Water Analysis for Sanitary Purposes"; 27.

§ *Ann. d. Chem. u. Pharm.* cliv; 336.

|| "Potable Water," 2d ed., Lond., 1880; pp. 15, 16, 22, 25, 26, 27, 28, 29.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Journal de Pharmacie et de Chimie.
July, 1882.

Researches on the Absorption of Gases by Platinum.—M. Berthelot.—Already noticed.

Report of M. Dumas on the Memoir concerning Albumenoid Matters presented by M. Béchamp to the Academy of Sciences.—From the *Comptes Rendus*.

Action of Oxygenated Water on Organic Matters and Fermentations.—MM. Paul Bert and P. Regnard.—Already noticed.

Phosphorescence and Oxidation of Phosphorus.—Isidore Corne.—The evaporation of phosphorus is the principal cause of phosphorescence, and not oxygen. Phosphorus is not attacked directly by common oxygen, and its oxidation is consecutive on its evaporation. This evaporation produces electricity, which ozonises the oxygen; in this state it attacks the phosphorus.

Determination of the Nitrogenised Matters of Urine from a Hydrological Point of View.—Dr. H. Byasson.—The author proposes to remove from a known volume of urine all the nitrogenous organic substances other than urea, by means of a solution of potassium permanganate. In the urine thus treated he determines the urea by means of sodium hypobromite, the nitrogen liberated belonging entirely to this substance. He then precipitates a known volume of urine with mercuric nitrate, and in the filtrate he determines the ternary matter by means of permanganate. The total quantity of solution of permanganate oxidising a known volume of urine being known, and also that which acts upon the ternary matters, the difference gives the nitrogenous matters other than urea. The barytic precipitate of a known volume of urine is treated with permanganate. The uric acid present is oxidised, and the proportion of permanganate employed gives the quantity of uric acid contained in the urine.

On Yolk of Egg.—P. Carles.—The author speaks of the adulteration of the yolks of eggs in their non-alimentary applications.

Presence and Determination of Copper in Bread.—J. Van der Berghe.—The author being struck with the constancy of the proportion of copper found in bread, was led to make an examination of wheat. In a million parts of this grain he found 9.24 of metallic copper, whilst oats contained 10.8 parts in the same quantity. He had previously ascertained the purity of his reagents, and the gas-burners employed were specially constructed of iron. The capsule (porcelain) was supported on a platinum triangle.

New Reagent for Sulphur and Nitro-benzol.—M. Brunner.—The author mixes the substance under examination with strong potassa lye, and adds a few drops of nitro-benzol and alcohol, and allows the mixture to stand at the common temperature. After some time, if sulphur or alkaline sulphides are present, there appears a red colouration, from the reduction of nitro-benzol. The inverse reaction can be used for the detection of nitro-benzol.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 2, March and April, 1882.

Procedures of MM. A. Classen and A. von Reiss for the Electrolytic Separation and Determination of Metals.—V. Francken.—This paper will be inserted at length.

Method for Purifying Arseniferous Copper.—J. Garnier.—From the *Comptes Rendus*.

The Magnesia Industry.—T. Schlössing.—Taken from the *Comptes Rendus*.

Experimental Researches on the Decomposition of Potassium Picrate.—MM. Sarrau and Vieille.—From the *Comptes Rendus*.

Cosmos Les Mondes.
No. 10, July 8, 1882.

The Sanitary Properties of Iron.—The author points out that certain wines, and especially those of Bordeaux, hold in solution a larger proportion of iron than most so-called chalybeate waters.

No. 11, July 15, 1882.

Dinitro-quinine Mono-hydrate.—F. Renni.—On treating quinine sulphate with a mixture of concentrated nitric and sulphuric acid and precipitating with ammonia a yellowish brown body is obtained, corresponding to the formula $(C_{20}H_{22}NO)_2N_2O_2 \cdot H_2O$. This new body does not produce the reactions of quinine with chlorine water and ammonia.

No. 12, July 22, 1882.

Isomorphism.—W. Spring.—The author has observed that all alums expand equally between 0° and 60°. This result leads him to think that equal expansion is the essential characteristic of isomorphism.

Malaria in the District of Rome.—Prof. Tucci, of Veletri, finds the cause of the superior sanitary condition of the Agro Romano in antiquity to the system of deep drainage practised by the Romans, their sewers being often at a level of 15 metres below the surface. The superficial drainage of the present day he thinks scarcely more salubrious than the stagnation of the ground waters, owing to the combined action of the water and the atmosphere upon the tufa which lies below the surface soil.

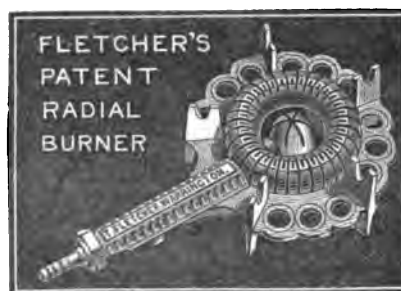
Colouring-Matter of Urines.—Dr. E. Neusser.—The deep red colour of the urine in tuberculosis, fatty degeneration of the heart, and *morbus Brightii*, is traced to hæmato-porphyrine, spectroscopically identical with oxy-hæmo-globine.

No. 13, July 29, 1882.

An Isomeric Modification of the Ferric Hydrate belonging to the Series *a*.—Dr. D. Tommasi.—The compound in question, which the author names *ab*, is obtained by adding to 200 c.c. distilled water 5 c.c. of liquid ferric chloride containing 23.17 per cent Fe_2Cl_3 , and adding to the solution 1 gram. magnesium. The ferric hydrate precipitated is dissolved in glacial acetic acid. The solution is precipitated by sulphuric acid, and the precipitate is insoluble in acetic, nitric, and hydrochloric acids, and only dissolves in a large excess of sulphuric acid.

Electro-metallurgic Process of MM. Blas and Miest.—The authors have established the novel fact that if in electrolysis we replace the metal of the anode by sulphuretted ores in a state of compression, the latter may serve themselves as anodes. Further, if we place such anodes in a bath of a suitable electrolytic salt, of the same metallic base as the metal of the ore, and let the electric current act in the bath, the result is that all the sulphur of the ore is precipitated upon the anode, and falls from thence to the bottom of the bath. In the meantime there is formed upon the cathode a deposit or precipitate of metal liberated from the salt, which forms the electrolytic bath. On the other hand, the acid of the bath, in proportion as it is set free, appropriates an equivalent proportion of the metal contained in the ore placed at the anode. In this manner the neutral electrolytic bath is re-constituted without ceasing and serves indefinitely.

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ANALYSIS BY JOHN PATTINSON, ESQ.

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THE CHEMICAL NEWS

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4 SEP 82

TO THE MATHEMATICAL AND
PHYSICAL SCIENCE SECTION
OF THE BRITISH ASSOCIATION

LORD RAYLEIGH, M.A., F.R.S., F.R.A.S.

of my predecessors in this chair, I
by the most useful form which a
uld take, would be a summary of
or of some important branch of
rs. But the difficulties of such
I do not feel myself equal to
few remarks which I have to
it may be thought of a com-
hope is that they may have
ame of mind suitable for

which come under our
the methods by which
ith, although a sign of
of considerable diffi-
almost inevitable
come about that
our section is un-
hose importance
se any interest
the authors of
and, and to confine within
discussion of points of less general

Even within the limits of those departments whose founda-
tion is evidently experimental, there is room, and indeed
necessity, for great variety of treatment. One class of
investigators relies mainly upon reiterated appeals to ex-
periment to resolve the questions which appear still to be
open, while another prefers, with Thomas Young, to
base its decisions as far as possible upon deductions from
experiments already made by others. It is scarcely
necessary to say that in the present state of science both
methods are indispensable. Even where we may fairly
suppose that the fundamental principles are well estab-
lished, careful and often troublesome work is necessary
to determine with accuracy the constants which enter into
the expression of natural laws. In many cases the accuracy
desirable, even from a practical point of view, is hard to
attain. In many others, where the interest is mainly
theoretical, we cannot afford to neglect the confirmations
which our views may derive from the comparison of
measurements made in different fields and in face of dif-
ferent experimental difficulties. Examples of the inter-
dependence of measurements apparently distinct will
occur to every physicist. I may mention the absolute
determinations of electrical resistance, and of the amounts
of heat developed from electrical and mechanical work,
any two of which involve also the third, and the relation
of the velocity of sound to the mechanical and thermal
properties of air.

Where a measurement is isolated, and not likely to lead
to the solution of any open question, it is doubtless pos-
sible to spend upon it time and attention that might with
advantage be otherwise bestowed. In such a case we may
properly be satisfied for a time with work of a less severe
and accurate character, knowing that with the progress of
knowledge the way is sure to be smoothed both by a better
appreciation of the difficulties involved, and by the inven-
tion of improved experimental appliances. I hope I shall
not be misunderstood as underrating the importance of
great accuracy in its proper place if I express the opinion

that the desire for it has sometimes had a prejudicial effect.
In cases where a rough result would have sufficed for all
immediate purposes, no measurement at all has been
attempted, because the circumstances rendered it unlikely
that a high standard of precision could be attained.
Whether our aim be more or less ambitious, it is important
to recognise the limitations to which our methods are
necessarily subject, and as far as possible to estimate the
extent to which our results are uncertain. The compari-
son of estimates of uncertainty made before and after the
execution of a set of measurements may sometimes be
humiliating, but it is always instructive.

Even when our results show no greater discrepancies
than we were originally prepared for, it is well to err on
the side of modesty in estimating their trustworthiness.
The history of science teaches only too plainly the lesson
that no single method is absolutely to be relied upon, that
sources of error lurk where they are least expected, and
that they may escape the notice of the most experienced
and conscientious worker. It is only by the concurrence
of evidence of various kinds and from various sources that
practical certainty may at last be attained, and complete
confidence justified. Perhaps I may be allowed to illus-
trate my meaning by reference to a subject which has
engaged a good deal of my attention for the last two
years—the absolute measurement of electrical resistance.
The unit commonly employed in this country is founded
upon experiments made about twenty years ago by a dis-
tinguished committee of this Association, and was
intended to represent an absolute resistance of 10^9 C.G.S.,
i.e., one ohm. The method employed by the committee at
the recommendation of Sir W. Thomson (it had been
originally proposed by Weber) consisted in observing the
deflection from the magnetic meridian of a needle suspended
at the centre of a coil of insulated wire, which formed a
closed circuit, and was made to revolve with uniform and
known speed about a vertical axis. From the speed and
deflection in combination with the mean radius of the coil
and the number of its turns, the absolute resistance of the
coil, and thence of any other standard, can be determined.

About ten years later Kohlrausch attacked the problem
by another method, which it would take too long to ex-
plain, and arrived at the result that the B.A. unit was
equal to 1.02 ohms—about two per cent too large. Row-
land, in America, by a comparison between the steady
battery current flowing in a primary coil with the transient
current developed in a secondary coil when the primary
current is reversed, found that the B.A. unit was 0.991
ohm. Lorentz, using a different method again, found
 0.980 , while H. Weber, from distinct experiments, arrived
at the conclusion that the B.A. unit was correct. It will
be seen that the results obtained by these highly competent
observers range over about four per cent. Two new deter-
minations have lately been made in the Cavendish labora-
tory at Cambridge, one by myself with the method of the
revolving coil, and another by Mr. Glazebrook, who used
a modification of the method followed by Rowland, with
the result that the B.A. unit is 0.986 ohm. I am now
engaged upon a third determination, using a method which
is a modification of that of Lorentz.

In another important part of the field of experimental
science, where the subject-matter is ill understood, and
the work is qualitative rather than quantitative, success
depends more directly upon sagacity and genius. It must
be admitted that much labour spent in this kind of work
is ill-directed. Bulky records of crude and uninterpreted
observations are not science, nor even in many cases the
raw material out of which science will be constructed.
The door of experiment stands always open; and when
the question is ripe, and the man is found, he will nine
times out of ten find it necessary to go through the work
again. Observations made by the way, and under favour-
able conditions, may often give rise to valuable suggestions,
but these must be tested by experiment, in which the con-
ditions are simplified to the utmost, before they
claim to acceptance.

When an unexpected effect is observed, the question will arise whether or not an explanation can be found upon admitted principles. Sometimes the answer can be quickly given; but more often it will happen that an assertion of what *ought* to have been expected can only be made as the result of an elaborate discussion of the circumstances of the case, and this discussion must generally be mathematical in its spirit, if not in its form. In repeating, at the beginning of the century, the well-known experiment of the inaudibility of a bell rung *in vacuo*, Leslie made the interesting observation that the presence of hydrogen was inimical to the production of sound, so that not merely was the sound less in hydrogen than in air of equal pressure, but that the actual addition of hydrogen to rarefied air caused a diminution in the intensity of sound. How is this remarkable fact to be explained? Does it prove that, as Herschel was inclined to think, a mixture of gases of widely different densities differs in its acoustical properties from a single gas? These questions could scarcely be answered satisfactorily but by a mathematical investigation of the process by which vibrations are communicated from a vibrating solid body to the surrounding gas. Such an investigation, founded exclusively upon principles well established before the date of Leslie's observation, was undertaken years afterwards by Stokes, who proved that what Leslie observed was exactly what ought to have been expected. The addition of hydrogen to attenuated air increases the wave-length of vibrations of given pitch, and consequently the facility with which the gas can pass round the edge of the bell from the advancing to the retreating face, and thus escape those rarefactions and condensations which are essential to the formation of a complete sound wave. There remains no reason for supposing that the phenomenon depends upon any other elements than the density and pressure of the gaseous atmosphere, and a direct trial, *e.g.*, a comparison between air and a mixture of carbonic anhydride and hydrogen of like density, is almost superfluous.

Examples such as this, which might be multiplied *ad libitum*, show how difficult it often is for an experimenter rightly to interpret his results without the aid of mathematics. It is eminently desirable that the experimenter himself should be in a position to make the calculations, to which his work gives occasion, and from which in return he would often receive valuable hints for further experiment. I should like to see a course of mathematical instruction arranged with especial reference to physics, within which those whose bent was plainly towards experiment might, more or less completely, confine themselves. Probably a year spent judiciously on such a course would do more to qualify the student for actual work than two or three years of the usual mathematical curriculum. On the other side, it must be remembered that the human mind is limited, and that few can carry the weight of a complete mathematical armament without some repression of their energies in other directions. With many of us difficulty of remembering, if not want of time for acquiring, would impose an early limit. Here, as elsewhere, the natural advantages of a division of labour will assert themselves. Innate dexterity and facility in contrivance, backed by unflinching perseverance, may often conduct to successful discovery or invention a man who has little taste for speculation; and on the other hand the mathematician, endowed with genius and insight, may find a sufficient field for his energies in interpreting and systematising the work of others.

The different habits of mind of the two schools of physicists sometimes lead them to the adoption of antagonistic views on doubtful and difficult questions. The tendency of the purely experimental school is to rely almost exclusively upon direct evidence, even when it is obviously imperfect, and to disregard arguments which they stigmatise as theoretical. The tendency of the mathematician is to overrate the solidity of his theoretical structures, and to forget the narrowness of the experimental foundation upon which many of them rest.

By direct observation, one of the most experienced and successful experimenters of the last generation convinced himself that light of definite refrangibility was capable of further analysis by absorption. It has happened to myself, in the course of measurements of the absorbing power of various media for the different rays of the spectrum, to come across appearances at first sight strongly confirmatory of Brewster's views, and I can therefore understand the persistency with which he retained his opinion. But the possibility of further analysis of light of definite refrangibility (except by polarisation) is almost irreconcilable with the wave theory, which on the strongest grounds had been already accepted by most of Brewster's contemporaries; and in consequence his results, though urgently pressed, failed to convince the scientific world. Further experiment has fully justified this scepticism, and in the hands of Airy, Helmholtz, and others, has shown that the phenomena by which Brewster was misled can be explained by the unrecognised intrusion of diffused light. The anomalies disappear when sufficient precaution is taken that the refrangibility of the light observed shall really be definite.

On similar grounds undulationists early arrived at the conviction that physically light and invisible radiant heat are both vibrations of the same kind, differing merely in wave-length; but this view appears to have been accepted slowly, and almost reluctantly, by the experimental school.

When the facts which appear to conflict with theory are well defined and lend themselves easily to experiment and repetition, there ought to be no great delay at arriving at a judgment. Either the theory is upset, or the observations, if not altogether faulty, are found susceptible of another interpretation. The difficulty is greatest when the necessary conditions are uncertain, and their fulfilment rare and uncontrollable. In many such cases an attitude of reserve, in expectation of further evidence, is the only wise one. Premature judgments err perhaps as much on one side as on the other. Certainly in the past many extraordinary observations have met with an excessive incredulity. I may instance the fire-balls which sometimes occur during violent thunderstorms. When the telephone was first invented, the early reports of its performances were discredited by many on quite insufficient grounds.

It would be interesting, but too difficult and delicate a task, to enumerate and examine the various important questions which remain still undecided from the opposition of direct and indirect evidence. Merely as illustrations I will mention one or two in which I happen to have been interested. It has been sought to remedy the inconvenience caused by excessive reverberation of sound in cathedrals and other large unfurnished buildings by stretching wires overhead from one wall to another. In some cases no difference has been perceived, but in others it is thought that advantage has been gained. From a theoretical point of view it is difficult to believe that the wires could be of service. It is known that the vibrations of a wire do not communicate themselves in any appreciable degree directly to the air, but require the intervention of a sounding-board, from which we may infer that vibrations in the air would not readily communicate themselves to stretched wires. It seems more likely that the advantage supposed to have been gained in a few cases is imaginary than that the wires should really have played the part attributed to them.

The other subject on which, though with diffidence, I should like to make a remark or two, is that of Proust's law, according to which the atomic weights of the elements, or at any rate of many of them, stand in simple relation to that of hydrogen. Some chemists have repudiated strongly the importation of *a priori* views into the consideration of the question, and maintain that the only numbers worthy of recognition are the immediate results of experiment. Others, more impressed by the argument that the close approximations to simple numbers cannot be merely fortuitous, and more alive to the inevitable imper-

sections of our measurements, consider that the experimental evidence against the simple numbers is of a very slender character, balanced, if not outweighed, by the *a priori* argument in favour of simplicity. The subject is eminently one for further experiment; and as it is now engaging the attention of chemists, we may look forward to the settlement of the question by the present generation. The time has perhaps come when a redetermination of the densities of the principal gases may be desirable—an undertaking for which I have made some preparations.

If there is any truth in the views that I have been endeavouring to impress, our meetings in this section are amply justified. If the progress of science demands the comparison of evidence drawn from different sources, and fully appreciated only by minds of different order, what may we not gain from the opportunities here given for public discussion, and, perhaps more valuable still, private interchange of opinion? Let us endeavour, one and all, to turn them to the best account.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By Prof. G. D. LIVEING, M.A., F.R.S., F.C.S.,
President of the Section.

If I were asked in what direction chemical science had of late been making the most important advances, I should reply that it was in the attempt to place the dynamics of chemistry on a satisfactory basis, to render an account of the various phenomena of chemical action on the same mechanical principles as are acknowledged to be true in other branches of physics. I cannot say that chemistry can yet be reckoned amongst what are called the exact sciences, that the result of bringing together given matters under given circumstances can yet be deduced in more than a few special cases by mere mathematical processes from mechanical principles, but that some noteworthy advances have in recent years been made, which seem to bring such a solution of chemical problems more nearly within our reach.

To show how large a gap in our ideas of chemical dynamics has been bridged over within the last quarter of a century, I will quote the words of one of the largest minded philosophers of his time, who was one of the earliest promoters of this Association, and its President in 1841: Whewell, in a new and much altered edition of his "Philosophy of the Inductive Sciences," published in 1858, says:—"Since Newton's time the use of the word *attraction*, as expressing the cause of the union of the chemical elements of bodies, has been familiarly continued, and has no doubt been accompanied in the minds of many persons with an obscure notion that chemical attraction is in some way a kind of mechanical attraction of the particles of bodies. Yet the doctrine that *chemical attraction* and *mechanical attraction* are forces of the same kind has never, so far as I am aware, been worked out into a system of chemical theory; nor even applied with any distinctness as an explanation of any particular chemical phenomena. Any such attempt, indeed, could only tend to bring more clearly into view the entire inadequacy of such a mode of explanation. For the leading phenomena of chemistry are all of such a nature that no mechanical combination can serve to express them without an immense accumulation of additional hypotheses." ("History of Scientific Ideas," ii., 13.) And further on he says:—"We must consider the power which produces chemical combination as a peculiar principle, a special relation of the elements not rightly expressed in mathematical terms." (*Ibid.*, p. 14.)

The influence by which our ideas have gone round so as to be now the very opposite of those of the illustrious thinker whom I have just quoted, so that we should

ridicule the thought of looking for an explanation of chemical action on any but mechanical principles, is undoubtedly the progress which has been made in other branches of molecular physics. The indestructibility of matter has long been a formula familiar to chemists, but that the conservation of energy should be as universally true, even in regard to chemical actions, has only in recent years been fully recognised. This is certainly no new principle, it was developed mathematically generations ago; but the realisation that it is anything more than an abstraction, that it is the keynote of every rational explanation of physical phenomena, has been the foundation of recent progress in physical science; and if all energy be one, there can be but one code of dynamical laws which must apply to chemistry as well as to all other branches of physics. The development of the mechanical theory of heat, and of the molecular theories which have grown up in consequence of it, have done much to set our minds free from preconceived notions, and to induce us to build chemical theories on something more than unverified conjectures.

But how far can we say that mechanical principles are actually recognised as the true basis of rational chemistry? So far as I know no chemist denies that it is so, and yet how little do our text-books, even the most recent and the most highly reputed, show the predominance of this idea! How very small a portion of such books is taken up with it, how much seems utterly to ignore it or to be couched in language antagonistic to it! We still find chemical combinations described as if they were statical phenomena, and expressions used which imply that two perfectly elastic bodies can, by their mutual action alone, bring each other into fixed relative positions. We still find change of valency described as a suppression of "bonds of affinity," as if a suppression of forces were the usual course of nature, or as if it were possible that the same two forces, acting at the same place and in the same direction, should at one time neutralise one another, and at another time not neutralise one another. We still find saturated compounds spoken of as if the stability of a compound were independent of circumstances, and chemical combination no function of temperature and pressure. Beginners are sometimes helped by the invention of intermediate reactions in explanation of final results, without any reference to the dynamical conditions of the problem, without any consideration whether the fancied intermediate reactions imply a winding-up or a running-down of energy. In fact our long familiar chemical equations represent only the conservation of matter, and to keep always in mind the mechanical conditions of a reaction is as difficult to some of us as it is to think in a foreign language. Moreover, we still find in many of our text-books the old statical notion of chemical combination stereotyped in pictures of molecules. I do not, of course, mean to accuse the distinguished inventors of graphic formulæ of meaning to depict molecules, for I believe that they would agree with me in thinking that these diagrams do not any more nearly represent actual molecules than they represent the solar system; but unfortunately we cannot prevent beginners from regarding them as pictures, and moulding their ideas upon them. They present something easily grasped by the infant mind, and schoolmasters are fond of them; but only those who have each year to combat a fresh crop of misconceptions, and false mechanical notions engendered by them, can be aware how much they hinder, I won't say the advance, but the spread of real chemical science. If it be true that the illustrations of an artist like the late Hablot Browne give to our conceptions of the characters of a story a more definite and permanent, though perhaps a much modified form of what the author of the story intended to portray, it is equally true that the illustrations by which some, even great names amongst us, have tried to make us fancy that we had a true conception of some natural process, have become so fixed in our minds as to prevent us from seeing the true meaning of nature.

What, then, is the progress which I think has been made in physical chemistry? In the first place, notwithstanding the slowness with which new ideas replace old familiar images, the molecular theories developed by Clausius, Clerk-Maxwell, and Boltzmann, and by Sir W. Thomson, have been long enough before the world to have greatly loosened the hold upon our minds of many old notions. The rigid, unbreakable, impenetrable atoms of the Epicurean philosophy, made familiar to us by Lucretius, always presented difficulties which were only perhaps exceeded by those of the elastic atmospheres with which modern philosophers fancied them to be surrounded; but now the vortex theory, whether we think it probable or not, at least gives us a standing ground for the assertion that the supposed impenetrability of matter, and the curious compound of nucleus and atmosphere which had been invented to account for elasticity, are not necessary assumptions.

The kinetic theory of gases has analysed for us the different motions of the molecules in a mass of matter, and has facilitated the conception of the part which heat plays in chemical action. Hence we have had of late several attempts to reduce to a form susceptible of mathematical calculation the problems of chemistry. Most of these attempts have proceeded on the well-known mechanical principle that the change of *vis viva* of a system, in passing from an initial to a final configuration, is independent of the intermediate stages through which it may have passed provided the external conditions are unaltered; and on the principle of the dissipation of energy, that is to say, on the condition that the state of the system, if it be a stable one, must be such that the energy run down in reaching it is a maximum. These principles have been applied successfully to the solution of some particular cases of the equilibrium between a mixture of chemicals by Willard Gibbs, Berthelot, and others. By the first-mentioned principle all consideration of the intermediate stages by which the final result is reached is avoided. Quite recently Lemoigne has attacked the same problem on another principle. His principle is that of an equilibrium of antagonistic reactions in a mixture of materials, a mobile equilibrium, such as we are now familiar with, dependent on compensating effects; but he does not seem able to solve the problem in any great number of cases. In fact, the difficulty does not now lie so much in expressing mathematically the conditions of the problem, as in the defect of knowledge which depends upon experiment. And it is just in this that I think the outlook most hopeful. In some cases the patient work of weighing, measuring, and comparing, which is necessary to make our theoretic speculations of any substantial value, has been already done for us. The publication, three years since, of Berthelot's "Essay on Chemical Mechanics," has given us, in a collected form, a large quantity of data of the first importance, and now I am glad to say that the long labours of another worker in the same field, Thomsen, of Copenhagen, are in course of publication in a handy form. I think these two investigators have done more than anyone else of late years towards making it possible to give chemistry the rank of an exact science. But besides the data which they have supplied to us, there are others which are yet wanting. For instance, almost every equation of chemical equilibrium involves an expression depending on the specific heat of the materials. At present we do not know enough of the law of specific heats to be able to give in most cases a probable value to these expressions, but these and other data of the kind do not seem out of our reach, and we may hope that the same ingenuity and patience which has gained for us so much firm ground in thermal chemistry will extend it to the uncertain spots where we have yet no solid foundation.

Further, the laws of dissociation, so ably investigated by Deville, have taught us that the force called chemical affinity, by which we suppose the atoms of unlike matters are held together in a compound molecule, follows pre-

cisely the same laws as the force of cohesion by which particles of a similar kind are united in molecules. We have long known that the molecules of sulphur vapour are broken up into simpler molecules by elevation of temperature and condense again when the temperature is reduced. Other elementary substances behave in a similar way. We have within the last two or three years learnt that iodine is in part dissociated by a high temperature from molecules consisting of two chemical atoms into molecules consisting of only one such atom, and the same is true of chlorine and bromine. That some such change must occur in iodine was inferred as long ago as 1864 by the younger Mitscherlich. He argued that iodine is a compound body from the fact that it shows two spectra, one similar in character to those of metallic oxides and the other similar to the spectra of metals, and from the analogy in the behaviour of iodine to a metallic oxide in giving the one spectrum at one temperature and the other at a higher temperature: "from this," he says, "it would follow that iodine at ordinary temperatures and iodine at the temperature of a hydrogen flame must be considered as two different compounds, because the spectrum of iodine formed at ordinary temperatures" (that is, the absorption-spectrum of iodine vapour) "is different from that produced in a hydrogen flame." Also, "that bromine, though it gives no flame spectrum, gives one spectrum by absorption and another by the electric spark, and must therefore in its ordinary state be regarded as a compound." Also, that "the spectra formed by the flames of selenium, tellurium, and phosphorus, and those of sulphur and nitrogen given by feeble electric discharges, all have the character of the iodine flame spectrum, and these metalloids would therefore, if the above-expressed supposition with regard to iodine be confirmed, also be compound bodies." (*Phil. Mag.*, 1864, p. 188.) Since the paper from which the foregoing extract is taken was published, not only the metalloids but many metals have been found to give complicated spectra at one temperature and much simpler spectra at higher temperatures. Such are the channelled spectra of sodium and potassium, first described by Roscoe and Schuster, the channelled spectra of silver, bismuth, and other metals described by Lockyer and Roberts, and the ultra-violet channelled spectrum of tin recently photographed by Dewar and myself. Mitscherlich's hypothesis gives us a rational explanation of such multiple spectra produced by the same substance, and it has been accepted, in one form or another, by all spectroscopists since he wrote. Nevertheless, the existence of multiple spectra cannot be taken as a proof of allotropic modification unless the possibility of a chemical combination be excluded. The channelled spectrum which magnesium gives in hydrogen was mistaken by more than one observer for that of some modification of the simple metal, until it was shown that magnesium in nitrogen or other gases does not give it if no hydrogen is present, and that its persistence in hydrogen at high temperatures depends, as does the permanence of chemical combinations, on the pressure of the gas. If, however, homogeneous molecules are dissociated by heat, so also are heterogeneous molecules, formed, as we say, by chemical combination, split up by elevation of temperature, to unite again on cooling, or when the pressure is increased within certain limits. Nor is there any essential difference in character between a chemical compound and an element beyond that of facility of decomposition. If we could not so easily resolve them into their constituents, and were to disregard the difference of their spectra, no one would suppose ammonia to be differently constituted from potassium, or cyanogen from chlorine. Indeed, chemists have long been in the habit of considering the union of two atoms in a molecule of ordinary hydrogen or chlorine as a species of chemical combination; but when we find that the combinations of particles of the same kind are as definite as those of particles of different kinds, and that they are both subject to precisely the same mechanical laws, we

are hardly justified in regarding the forces by which they are produced as essentially different. To get rid of a gratuitous hypothesis in chemistry must be a great gain.

But it may be asked, why stop here? Why may not the chemical elements be further broken up by still higher temperatures? *A priori* and from analogy such a supposition is extremely probable. The notion that there is but one elementary kind of matter is at least as old as Thales, and underlies Prout's hypothesis that the atomic weights of our elements are all multiples of that of hydrogen. This famous hypothesis has gone up and down in the scale of credibility many times during the present century. About seventeen years ago the publication of Stas's new determinations of combining weights, carried out on a scale never before attempted, and with all the refinements which the growth of our knowledge could suggest, was thought to have given it its deathblow. But a reaction has set in since that time. The periodic recurrence of the properties of elements with regular additions to the atomic weights, like octaves in a musical scale, put forcibly before us by Mendelejeff, makes it difficult not to think that there is a simple relation between the atomic weights, though there may be causes producing slight perturbations of such a relation. Quite recently a fresh revision of the combining weights has been made on the other side of the Atlantic by Professor F. W. Clarke. He has collected all the determinations made by different observers, and after rejecting such as from defective methods were untrustworthy, has applied to the remainder such corrections as newer experiences have suggested, and then deduced from the corrected numbers the most probable values by the methods of the theory of errors. Professor Clarke has done a piece of work of the highest utility, for which chemists must be grateful; nevertheless, he has not carried the revision so far as it might be carried. He has, to begin with, rightly separated the several sets of observations, and deduced the most probable number from each set by itself, but in combining the various sets for the final determination of the numbers adopted, he has treated the results obtained by different methods, as if they were a set of observations all presumably of equal value, so that the most probable numbers could be deduced by the method of least squares. He has not attempted any discussion of the different methods with a view to an estimate of the relative values of the results obtained by them, nor made any difference between the values of the figures deduced from operations on the large scale employed by Stas and those arrived at on the small scale of other observers. Any sort of handicapping of methods is no doubt a very difficult and delicate operation, and requires more than the judgment of an Admiral Rous, but without it the question whether the numbers adopted are the best obtainable will always be an open one. It is, however, a very noteworthy fact, that in almost every case the numbers deduced from Stas's experiments, taken by themselves, coincide very closely indeed with the most probable numbers derived by the method of least squares from the whole of the recorded estimates. On the whole, Professor Clarke concludes that Prout's hypothesis, as modified by Dumas, is still an open question; that is to say, his final numbers differ from whole multiples of a common unit by quantities which lie within the limits of error of observation and experiment.

Let us turn again to the evidence afforded by our most powerful instrument for inspecting the inner constitution of matter, the spectroscope. A few years ago Mr. Lockyer supposed that the coincidence of rays emitted by different chemical elements, particularly when those rays were developed in the spark of a powerful induction coil and in the high temperatures of the sun and stars, gave evidence of a common element in the composition of the metals which produced the coincident rays. Such an argument could not be drawn from the coincidences unless they were exact, and the identity of the lines could only be tested by means of spectroscopes of great resolving power. By the use of the well-known Rutherford gratings,

Young in America had found that most of the solar lines which had been ascribed to two metals were in reality double, and Dewar and I, working on the terrestrial elements in the electric arc, had found the actual coincidences to be very few indeed. These observations, even with Rutherford gratings, were delicate enough; but quite recently M. Fievez, of the Brussels Observatory, has brought to bear on this question a spectroscope of unexampled power. By combining two of the Astronomer Royal's highly dispersive half-prisms with a Rutherford grating of 17,296 lines to the inch, he has obtained a dispersion quadruple that of Thollon's combination of prisms. Bringing this to bear on the sun he has mapped the solar spectrum from a little below C to somewhere above F, on a scale one-third greater than that of Vogel's map, and has not only confirmed the work of Young, Dewar, and myself, but has resolved some lines which were not divisible by such dispersive power as we had at command. This result cannot fail to shake our belief, if we had any, in the existence of any common constituent of the chemical elements; but it does not touch the evidence which the spectroscope affords us, that many of our elements, in the state in which we know them, must have a very complex molecular structure. I cannot illustrate this point better than by the spectra of two of our commonest elements, magnesium and iron. We have good reason to think the molecule of magnesium to be as simple as that of any chemical element, and we find its spectrum to be one of the simplest, consisting of a series of triplets which repeat each other in a regular way and are probably harmonically related, and of a comparatively small number of single lines, of which also some may be harmonics. The spectrum of iron, on the other hand, presents thousands of lines distributed irregularly through the whole length, not only of the visible, but of the ultra-violet region. Make what allowance you please for unknown harmonic relations, and for lines which are not reversible and may not be directly due to vibrations of the molecules, we still have a number of immense vibrations, so that we can hardly conceive any single molecule to be capable of all of them, and are almost driven to ascribe them to a mixture of differing molecules, though we have as yet no independent evidence of this, and no satisfactory proof that any of this mixture are of the same kind as occur in other elements.

M. Fievez's combination is a great advance in resolving power, but Professor Rowland, of the Johns Hopkins University, promises us gratings not only exceeding Rutherford's both in dimensions and accuracy of ruling, but ruled upon curved surfaces so as to dispense with the use of telescopes and avoid all variations in focussing the different orders of spectra. His instruments, if they come up to the promise he holds out, will enable us to solve many questions which are difficult to answer with our present appliances.

But to return to the chemical elements: the spectroscope has in the last few years revealed to us several new metals. I will not venture to say how many, for when several new metals more or less closely allied are discovered at the same time, the process of sifting out their differences is necessarily a slow one. We cannot tell yet whether any of them are to fill gaps in Mendelejeff's table, and so add strength to the conviction that there is a natural relation between the atomic weights and the chemical characters of our elementary substances, or whether they will add to the embarrassment in which we already find ourselves with regard to the relations of the cerium group of metals; whether we may welcome them as the supporters of order, or deprecate their coming as authors of confusion. Granting that the chemical characters of an element are connected with its atomic weight, we have, however, no right to assume them to be dependent on that factor alone. Why may there not be elements which, while they differ as little in atomic weight as do nickel and cobalt, are, on the other

similar to one another in all characters that their chemical separation is a matter of the greatest difficulty, and their difference only distinguishable by the spectroscope? The spectra may be thought to suggest so much, and how shall we decide the question? At any rate the complications of the spectroscopic problem can only be unravelled by the united efforts of the chemists and physicists, and by the exercise of extreme caution.

I cannot dismiss the subject of chemical dynamics without alluding to the ingenious theory by which the President of the Association has proposed to account for the conservation of solar energy. He supposes planetary space to be pervaded by an atmosphere which, except where it is condensed by the attraction of the sun and planets, is in a highly attenuated state. The sun and planets communicate some of their own motion of rotation to the atmosphere condensed about them, and he supposes that in this way an action like that of a blowing fan is set up, by which the equatorial part of the sun's atmosphere acquires such a velocity as to stream out to distances beyond the earth's orbit, while an equal quantity of gas is drawn in at the poles to maintain equilibrium. The gases thus driven to a distance in planetary space will of course be enormously expanded and highly attenuated, and in this state Dr. Siemens thinks that such of them as are compound may be decomposed by absorbing the solar radiation, and thus the kinetic energy of the sun's rays be converted into the potential energy of chemical separation. The separated elements, or partial compounds will in the circulation produced by the fanlike action of the solar rotation be carried back to the polar regions of the sun as fuel to maintain his temperature by condensation and re-combination. I will not discuss the mechanical part of this theory further than to remark that the fanlike action can only be carried on at the expense of the energy of the sun's rotation, which must in consequence be continually diminishing, and must in time become too slow to produce any sensible projection of the atmosphere into distant regions of planetary space. As to the chemical side of the theory, Dr. Siemens supposes the gases which pervade the planetary space to be not only of the same kind as the components of our own atmosphere, which on the kinetic theory of gases must diffuse through that space, but also such gases as are not found in our air, but are found occluded in meteorites which may be supposed to have acquired them in their previous wanderings. Amongst these he specially mentions hydrocarbons which form the self-luminous part of most comets. It is to these gases, together with aqueous vapour and carbonic acid, that he ascribes the principal part in the conservation of solar energy. That compound gases at the extremely low pressure of the planetary space are decomposed by solar radiation is not inconsistent with the laws of dissociation, for it is quite possible that some compounds may be decomposed at ordinary temperatures by mere reduction of pressure, and the radiation absorbed will be the more effective because it will directly affect the vibratory motion within the molecule, and may well produce chemical decomposition before it can, when the free path of the molecules is so much increased by the attenuation of the gas, assume the form of an increased temperature. Dr. Siemens, moreover, adduces a remarkable experiment in confirmation of this supposition. We know, too, the power which our atmosphere, and especially the water vapour in it, has of absorbing the infra-red rays, and that amongst the Fraunhofer lines some of the strongest groups are due to aqueous vapour; and the capital observation made by the spectroscopic observers at the last total eclipse, that the group of lines known as "B," which is one of those produced by aqueous vapour, is greatly strengthened when the sun's light passes by the edge of the moon and so through the lunar atmosphere, may be taken as a confirmation of the theory that gases like our atmosphere are diffused through space and concentrated about the planets. But if it be true that the compounds are decom-

posed by absorbing the sun's rays, we ought to find in our atmosphere the products of decomposition, we ought to find in it free hydrogen, carbonic oxide, and acetylene or some other hydrocarbons. The hydrogen, from its small specific gravity, would not be concentrated in the lower regions of our atmosphere in the same proportions as the denser gases, but carbonic oxide and hydrocarbons could not fail to be detected in the air if they formed any sensible proportion of the gases in the planetary space. That a large portion of the solar radiation is intercepted before it reaches the earth is no doubt true, for there are not only the dark bands which are increased by our atmosphere and may reasonably be attributed to the action of like gases pervading planetary space, but there is a continuous absorption of the ultra-violet spectrum beyond the line U, and Cornu has found that this absorption is not sensibly affected by our atmosphere, so that the substance, whatever it be that produces it, may be an agent in the process imagined by Dr. Siemens, but cannot be the means of restoring to the sun any portion of his radiant energy which reaches our distance from him.

Dr. Siemens explains the self-luminous character of comets by the theory that the streams of meteoric stones of which they are supposed to consist bring from stellar space hydrocarbon and other gases occluded within them, and that in consequence of the rise of temperature due to the frictional resistance of such a divided mass moving with enormous velocity, aided by attractive condensation, the occluded gases will be driven out and burnt, the flame giving rise to the original light emitted by the nucleus. Now the spectrum of most comets shows only the principal bands of a Bunsen burner, and is therefore adequately explained by the flame of gas containing hydrocarbons such as have been found in meteorites; but Dr. Huggins has observed in the spectrum of more than one comet, not only hydrocarbon, but cyanogen bands; and, although carbon and nitrogen combine readily in the electric arc, a coal-gas flame in air shows no trace of the spectrum of cyanogen, and it would certainly put some strain on our credulity if it were asserted that cyanogen was one of the gases brought ready-formed by meteorites from stellar space. Dewar and I have, however, recently shown that if nitrogen already in combination, as, for instance, ammonia, be brought into a hydrocarbon flame, cyanogen is produced in sufficient amount to give in a photograph (though not so as to be directly visible) the characteristic spectrum of cyanogen as it appears in the comet. It is therefore no longer necessary to make any other supposition to account for the cyanogen bands in the spectra of comets, than that ammonia, or some such compound of nitrogen, is present as well as hydrocarbons in a state of ignition.

Quite recently Dr. Huggins has observed that the principal comet of this year has a spectrum of an entirely different character, but he is not yet able to say to what elements or compounds it is probably due. The notion that comets may bring us news of distant parts of stellar space, towards which our system is driving, where the atmosphere is not like ours—oxygen and nitrogen—but hydrogen and hydrocarbons, may fascinate the fancy, but the laws of occlusion oblige us to think that the meteorites have not merely wandered through an attenuated atmosphere of hydrogen and hydrocarbons, but have cooled in a much denser atmosphere of those substances, which we can only conceive as concentrated by the presence of a star or some large aggregation of matter. They may, perchance, have come from some nebulous mass, for Draper and Huggins tell us that in the great nebula in Orion hydrogen is dense enough and hot enough to show some of its characteristic lines, besides the F line which is seen in other nebulae, and is the last to disappear by reduction of density. No comet on visiting our system a second time can repeat the exclusion of its occluded gases unless its store has been replenished in the interval, and it will be interesting to see, when Halley's comet next

returns, whether it shines only by reflected light or gives us, like so many others, the banded spectrum of hydrocarbons.

THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.*

By Prof. J. W. MALLET, F.R.S., University of Virginia.

(Continued from p. 92.)

REUBEN HAINES, of Philadelphia, has furnished† the details of some cases in his own experience, which he says are "in partial corroboration of the opinions of Mr. Ekin."

Among the artificially polluted waters of the investigation now reported on, there are a number of samples of such general character as to attach to them the gravest suspicion on sanitary grounds, suspicion corroborated in sundry cases by the biological tests applied to them; in which, nevertheless, nitrates and nitrites are not found; but in these waters we find the quantity of organic matter extraordinarily large, and generally accompanied by very large amounts of ammonia—*e.g.*, Nos. 119, 120, 121 containing water in which the dead body of an animal had been allowed to macerate; Nos. 122, 123, 124 containing much blood from a slaughter-house, and Nos. 137 and 138 containing the dejecta from typhoid-fever patients.

Looking at the results from the natural waters of Classes I. and II., and bearing in mind the conclusions reached by Müller, Schloesing and Müntz, Storer, Warington, and others; as to the process of nitrification being due to the presence of an organised ferment or ferments of bacterial character, the idea suggests itself whether the noxious character of waters containing largely of nitrates and nitrites—themselves presumed to be harmless,—and but very little organic matter—which ought to be present, of some sort, to support the "previous contamination" view—may not be in reality due to the presence of a special nitrifying ferment, itself to be classed among the lower organisms capable of propagating disease.

4. Two points require to be borne in mind, suggestive of caution in drawing such conclusions as the above in regard to the sanitary in connection with the chemical character of water.

In the first place, the samples examined may possibly have undergone chemical change in the interval from their collection to their reaching the analysts, so that, for example, organic matter may have disappeared or nitrates may have been formed. With the precautions taken to lose as little time as possible, there does not seem much likelihood of such changes having occurred to so serious an extent as to essentially alter the character of the water.

In the second place, with the object which I had in view, of obtaining samples of water capable of producing disease, it was necessary to take what may be called *exaggerated instances* of mischief—well marked or comparatively violent cases of illness—since no others could well be traced with sufficient strength of probability to their supposed cause, and it may very possibly be that the organic impurities present in the waters concerned in such cases are not the same as those which would produce slighter, but in time serious, ill effects. Slighter forms of disease, in reality attributable to drinking-water, may perhaps be numerous, and possibly of various types, but generally the difficulty will be too great of securing, in view of the many factors concerned, any satisfactory evidence as to their cause. The collection of strongly-marked

cases only, neglecting slighter ones if such exist, involves to some extent the same fault in principle as the commonly applied test of the death-rate for particular diseases in the discussion of local sanitary conditions; there may be numerous cases of illness, with but few deaths. The same difficulty also is experienced in trying pathological experiments on the lower animals; only strongly marked effects can be noted or satisfactorily connected with their supposed cause.

5. In regard to the comparatively rough determinations of chlorine, the results are, in many of the cases of water from shallow wells, significant enough of contamination by fluid animal excreta. The amounts of chlorine found in specimens Nos. 2, 3, and 4 of water from the deep artesian wells at Charleston, S.C., and in No. 22 from a well near the sea on Staten Island, and Nos. 50 and 51 from a well, and No. 52 from a pond in the neighbourhood of the sea at Newport, R.I., illustrate the need for thought as to the natural source of a water in drawing conclusions in connection with the presence of chlorides. Even in cases in which chlorine has come in with organic matter, the impropriety of too hastily deciding, as is sometimes done, that a small quantity indicates vegetable and a large amount animal contamination, as illustrated by the results for No. 65, containing an infusion of hay or dry herbage,* and for Nos. 87 and 88, containing the alkaline washings from wood pulp at a paper-mill, in contrast with those for Nos. 120 and 121, containing a very foul infusion of the body of a dead animal, and for Nos. 138 and 139, containing morbid animal matter from cases of typhoid and scarlet fever.

Biological Results Contrasted with the Actual Character of the Waters Examined.

The lists of waters marked (independently) by Professor Martin and Dr. Hartwell as "dangerous" and "suspicious" on the basis of the biological observations are summarised, in connection with the classes represented, in Table XXIII.

TABLE XXIII.—Biological Classification of Waters.

Class.	No. in class.	Professor Martin.		Dr. Hartwell.	
		Dangerous.	Suspicious.	Dangerous.	Suspicious.
I. ..	19	—	4	—	7
II. ..	19	—	2	—	1
III. ..	20	2	1	1	3
IV. ..	20	3	3	3	2
V. ..	21	4	5	2	10
VI. ..	21	4	1	1	6
VII. ..	15	4	3	4	7
VIII. ..	4	1	2	2	1

x. It is evident on inspection of this table for Classes I. to III., that, as has been remarked on a previous page, the biological methods employed will not afford the means of deciding between a wholesome and an unwholesome natural water. Several of the waters believed to be fairly wholesome for human consumption, certainly in use for drinking purposes on a large scale, are marked "suspicious," while not one of the waters believed to have proved themselves pernicious when used by man are set down as "dangerous."

2. In many cases the waters which produced most decided effects upon the rabbits contained *very large* amounts of organic matter, so large as to probably invalidate a comparison with the natural waters or with much more dilute specimens of artificial preparation.

3. On the other hand, we find in several instances, on comparing the pathological results from three different strengths of a solution of the same organic material, that it is not the strongest which has produced the most marked effects.

4. In probable support of the idea that it is not mainly the quantity of organic matter, but the presence and

* It is possible that salt may have been sprinkled over this hay in curing it, as is sometimes done, though I have no special reason to suppose so. It was upland, not salt-marsh, hay.

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† "Methods for Judging of the Wholesomeness of Drinking-water." From "Journal of the Franklin Institute," February, 1881.

‡ *Comptes Rendus*: 84, 301; 85, 22, 1018. *Four. Chem. Soc.* (Lond.), January, 1876, 44; July, 1879, 429. *CHEMICAL NEWS*, November 4, 1882, 217, &c.

nature of low organisms which render drinking-water unwholesome, such cases deserve attention, as No. 83 in contrast with Nos. 84 and 85, and also Nos. 131, 132, and 133 (if the deaths of comparison rabbits be not considered to vitiate the results) in contrast with Nos. 134, 135, and 136. Here the pernicious character of waters containing relatively but very little organic matter seems to be distinctly indicated.

5. It is pretty plain that much difficulty in the interpretation of the biological results arises from two great differences of absolute strength in the solutions of organic matter used. In any future attempt to extend investigation in this direction it would be well to more nearly equalise the dilution, though it might perhaps prove necessary to use in all cases more organic matter than is usually found in potable water of natural origin.

Chemical Results as to Animal in Contrast with Vegetable Organic Matter in Water.

1. In general the conclusions are sustained which have been usually drawn in regard to the source of organic matter, based on the more highly nitrogenous character of that from animal than that from vegetable debris. This remark applies to the ratio of organic C:N obtained by the combustion process (although the value of the figures is much reduced by the errors in the method which have been pointed out), and also to the amounts of albumenoid ammonia obtained, and the consumption of oxygen from acid permanganate.

2. But the necessity for caution in drawing such conclusions, or the propriety of substituting for the statement that a given water is polluted by, say, animal matter, rather the simple assertion that the polluting material is of highly nitrogenous character, is illustrated by such cases as Nos. 89, 90, and 91, containing the alkaline washings from the manufacture of starch, and Nos. 98, 99, and 100, containing the refuse from canning tomatoes. These waters might well be supposed to be contaminated with animal matter from the evidence afforded by the chemical results, interpreted in the usual way.

3. On the other hand, the results for Nos. 104, 105, and 106, containing a water infusion of human fæces, especially the C:N ratio, might be taken to indicate the presence of vegetable matter. This fact, well deserving attention from a sanitary point of view, is opposed to the evidence of pollution obtained where urine alone is concerned, and might modify the conclusions drawn in cases involving drainage from mixed solid and fluid excreta. The fact itself is intelligible in view of the tendency to accumulation and ultimate rejection from the intestines of the vegetable fibre* of our food and the products of its limited alteration, as well as the highly carbonaceous character of the biliary discharges.

4. The different rate of removal from water of organic carbon and organic nitrogen is in one form illustrated by the comparison of No. 119 with No. 120 and No. 121, all three containing the watery liquid in which the body of a dead animal had been macerated, as also No. 128 in contrast with Nos. 129 and 130, all containing washings from wool. The true effect of the changes taking place in the water is, however, blended with and partially obscured by the effect of difference of strength on the errors which have been pointed out belonging to determinations by the combustion process. The bearing of such changes in the C:N ratio, from both causes, on the conclusions to be drawn as to the source of pollution, is very obvious.

5. Dr. Smart, in interpreting his results by the albumenoid-ammonia process, aided, however, in some cases, by his application of the Kubel form of the permanganate process, has for most of the waters in which the organic matter was of known character (though unknown at the time to him) attempted to distinguish between that of vegetable and that of animal origin, and his conclusions

* The infusion was strained but not filtered. It contains a good deal of very fine suspended material.

are given in column 45 of Table X. On examining these it will be seen that in a very large proportion of cases he has been right, while some of those in which his deductions are incorrect are intelligible in the light of full consideration of all the facts. Thus, he has referred Nos. 105 and 106, containing infusion of human fæces, to the class of vegetable matter, this case having been alluded to above; and Nos. 108 and 109, containing drainings from a pile of stable manure, to the same class, this being in many respects an analogous case, and, indeed, a more strongly marked one of its kind.

(To be continued.)

NOTICES OF BOOKS.

Elementary Chemical Arithmetic, with 1100 Problems.
By SYDNEY LUPTON, M.A., Assistant Master in Harrow School. London: Macmillan and Co.

SOME years ago Prof. R. Galloway threw out the suggestion that chemical facts might be more firmly and clearly fixed in the mind by the use of numerical problems on the properties and reactions of substances. Hence has arisen, ultimately, the present volume, which to the chemists of the earlier part of the century would have seemed a strange aberration. Its nature will perhaps be better understood by means of examples. We find the following questions:—50 grms. of potassium chlorate are heated: what mass of oxygen is given off? A gm. of bleaching-powder is boiled with water and cupric oxide: what volume of oxygen at 14° is given off? The *Great Eastern* is 699 feet long, 82 feet broad, and 62 feet deep: find each dimension in metres. (We do not see anything of a chemical nature in this question). 100 grms. of gypsum are heated: what volume of steam at 300° is given off? A solution of hydrogen dioxide (density 1.455) gives twenty times its volume of oxygen when boiled: find its percentage composition by volume. Under the head "The Atmosphere" there occur some questions whose right to be viewed as chemical is at least questionable. Thus:—Westminster Hall is 290 feet long, 68 feet wide, and 110 feet high: how many tons of air does it contain?

The area of the basin of the Thames is 6000 square miles: a rainfall of 3.937 inches upon it is how many cubic metres of water? On October 14, 1881, the pressure of wind at Greenwich was 53 lbs. per square foot: how many grms. per square centimetre is the pressure equivalent to? The pressure on the same day at Birkenhead was 77 lbs. per square foot: how many tons pressure was there on a wall 50 feet high and 60 feet long? If the rate of wind was 65 miles per hour, how many feet per second was it?

A steel wire 1 m.m. square will just carry 70 kilos.: how many tons will a rod of such steel one foot square sustain?

A cubic crystal of rock-salt weighs 40.2 grms.: find the length of its edge.

How many yards of wire $\frac{1}{8}$ inch in diameter can be made from an ounce of magnesium?

Under "Iron" (p. 110, No. 9) we find the problem—"On January 18th, 1881, the barometer in London stood at 30.961 inches: how many m.m. high was it?"

Again, under "Cobalt and Nickel," occurs the curious question—"If a cubic foot of water weighs 62.4 lbs.: find the diameter in inches of a cast-iron (density 7.25) 32 lbs. cannon ball?"

Finally, under chromium, we read (p. 221, No. 8)—"The three most elevated buildings in Europe are the Hospice de St. Gotthardt, 2075 m.; the Hospice de St. Bernard, 2491 m.; the Observatory on Mount Etna, 2942 m. above sea-level: find each of these altitudes in feet!"

Leaving out of view the many non-chemical questions,

of which we have not noticed a fourth part, we have now to turn to the general value of the book. To us it seems that as an adjunct to a full course of actual laboratory work it will prove exceedingly useful. But in schools and colleges like those of England, where there is already such a strong propensity to teach physical science by books, pen, and paper instead of by experiment and observation, there is a possibility that this treatise, or rather the system which it expounds, may be made to serve as a substitute for an actual practical training. This result, we think, would be very deplorable; for as far as we are able to judge, a man might be able to answer every question in the book and yet be utterly incompetent to execute an analysis, to conduct an investigation, or even to identify the simplest body placed before him. But we repeat, as an adjunct to experimental instruction it may be made to play an important and much needed part.

The Elements of Machine Design. By W. CAWTHORNE UNWIN, B.Sc. Fourth edition, revised and enlarged. London: Longmans, Green, and Co.

THIS work, which forms one of the series of "Text-Books of Science" issued by the above publishers, is evidently appreciated, since a fourth edition has been found necessary within five years from its first appearance. This is the more satisfactory as affording proof that the frequent occurrence of mathematical symbols in its pages has not rendered it, as was foretold by certain authorities, a mere algebraical puzzle to practical men. There can be no occasion for us to summarise the teachings of a work evidently so well known, and which scarcely falls within the ordinary limits of our cognizance. We will therefore merely express our pleasure at the success of a book which instead of supplying mere receipts and formulæ lays down principles.

Handbook of Patent Law of all Countries. By W. P. THOMPSON, C.E. London: Stevens and Sons. New York: Van Nostrand.

It may be thought a bold undertaking to sum up the patent laws of all countries in a treatise of 90 pages. It must, however, be admitted that the author has treated his difficult subject with much ability, and that no little disappointment, loss, and litigation would be saved were the principles here laid down familiar to inventors. The author in his opening paragraph points out implicitly the distinction between a patent and a monopoly. "The inventor gives to the public what it did not possess before—the full details of a new invention; the crown in return gives the inventor the exclusive right of working that invention for a limited period, at the end of which time the full benefit of the discovery reverts to the public." There is only one word which can here be objected to, *i.e.*, "reverts," which naturally and etymologically means that something which has once been the property of a man becomes his again after having for a season passed out of his possession. Now the right or power which falls to the public when a patent lapses is something which they never possessed before.

It is remarkable how by the present state of the law one of the original objects of the patent-system is nullified. That original object was to promote the arts and manufactures in this country by encouraging inventions at home, and by facilitating their importation from abroad. But we now grant patents to aliens residing abroad, who have not the remotest intention of working such patents in the United Kingdom. In fact their motive is to prevent such working. By this principle England is placed at a great disadvantage as compared with other countries, which insist upon an invention being worked in their territories as one of the conditions on which a patent is granted. It has been suggested that the best means of putting a check to this growing practice would be to render the importation from abroad of any article, the manufacture of which

is patented in England, contraband. It would then become the patentee's interest to work his invention in England or to grant licenses. However, it is the purpose of the author merely to explain the law as it is and not to point out its defects or to propose improvements. The work, so far as it aims at going, will be extremely serviceable. Great and due weight is laid on the necessity for a thorough search before taking any steps. But chemical inventions may chance to have been anticipated by publication without ever having been the subject of a patent. Hence as far as they are concerned it is prudent to search technological works and journals. It is to be regretted that some recent arrangements of the Commissioners have made searches more difficult.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 5, July 31, 1882.

Period of Variable Condition which precedes Detonation, and the Conditions under which the Explosive Wave is Established.—MM. Berthelot and Vieille.—According to the observation of the authors the propagation of the explosive wave is a phenomenon quite distinct from ordinary combustion; it takes place only when the ignited section exerts the greatest possible pressure upon the next section,—that is to say, when the ignited gaseous molecules possess the maximum speed, and consequently the maximum *vis viva* of translation, which is merely the mechanical translation of the fact that they preserve almost the totality of the heat developed by the chemical reaction.

Electric Resistance of Glass at Low Temperatures.—G. Fousereau.—For ordinary glass, of sp. gr. 2.539, expressing the resistances per c.c. in millions of megohms, the author obtained the following results:—

Temperatures.	Resistances.
+61.2	0.705
+20.0	91.000
−17.0	7970.000

To form an idea of the greatness of this last resistance we may remark that it represents about twice the resistance of a copper wire, of 1 square millimetre section, extending from the Earth to Sirius. Hard Bohemian glass, of sp. gr. 2.431, is from ten to fifteen times more conductive than ordinary glass at the same temperature. Crystal glass, of sp. gr. 2.933, is from 1000 to 1500 times more insulating than common glass at the same temperature.

Heat of Solution of some Mixtures.—P. Chrostchoff.—On taking four salts containing two acids and two bases we obtain two systems of salts of the same empirical composition, but with a different distribution of the acids and the bases. The solution-heat of these mixtures enables us in certain cases to infer the constitution of such mixtures. The author has not succeeded in finding for ammonium sulphate a fact indicated by Rüdorff for ammonium nitrate—that evaporation at 100° gives a system of four salts, whilst an evaporation in the cold gives merely a system of two salts, always the same, independently of the initial temperature.

Action of Ammonia upon Copper Oxide.—E. J. Maumené.—Copper oxide is considered by some chemists as soluble in ammonia. Others have observed that the presence of an ammoniacal salt is needful. The author concludes from his experiments that the compound cuprammonium does not exist. The so-called ammoniac

salts are never formed of an acid combined with H_3NCuO , but always contain more than 1 equiv. ammonia to 1 of copper. Without hypothesis the sulphate is tribasic, the carbonate monobasic, and the phosphate sexbasic.

Composition of Wines prepared by Petiot's Process.—M. Aimé Girard.—The author finds that in wines prepared by this process the quantity of total extractive matter, of tartar, of tannin, and colouring-matter is smaller than in natural wines of the same growth.

Ethers of the Glycol, $\text{C}_{22}\text{H}_{14}\text{O}_2$.—G. Rousseau.—This memoir does not admit of useful abridgment.

Preparation of Acetyl-cyan-acetic Ether, and some of its Metallic Derivatives.—A. Haller and A. Held.—Acetyl-cyan-acetic ether has an acid reaction, and yields well-crystallised metallic derivatives.

Conditions of the Formation of the Rosanilines.—MM. A. Rosenstiehl and Gerber.—According to the authors we know at least six different rosanilines, isomeric or homologous. They confirm the conclusions of MM. E. and O. Fischer, according to which the concurrence of an alkaloid of the para-class is absolutely necessary for the production of magenta under normal industrial conditions.

Novel Use of Electrolysis in Dyeing and Printing.—Fr. Goppelsröder.—(See page 89).

Formation and Decomposition of Acetanilide.—M. Menshutkin.—Not suitable for abstraction.

Products of the Distillation of Resin.—A. Renard.—The author finds that the carbide $\text{C}_{10}\text{H}_{18}$, described in a former memoir, has not a constant composition, but is a mixture of a carbide, C_9H_{18} , with a small quantity of a carbide of the aromatic series.

Journal de Pharmacie et de Chimie.
August, 1882.

Note on the Barks of Remigia.—G. Planchon.—A pharmacological paper.

On Combustion effected by means of Nitrogen Binoxide.—M. Berthelot.—Already noticed.

On Plastered and Deplastered Wines.—P. Carles.—The author considers the removal of sulphuric acid from wines by means of salts of barium as a remedy worse than the disease. There is the risk of an excess of barium chloride remaining in the wine, and the certainty that the barium sulphate and the tartrate (which is likewise formed) are not absolutely insoluble, especially the latter.

MISCELLANEOUS.

The late Mr. Grosjean.—We wish to correct an error in our obituary notice of this gentleman. He was chemist at the Citric and Tartaric Acid Works of Sir J. Lawes, and not at the Chemical Manure Works as we had been given to understand.

The Siemens Gold Medal and Prize.—An annual medal and prize of the joint value of 20 guineas have been founded by Dr. C. W. Siemens, F.R.S., "with the object of stimulating the students of King's College, London, to a high standard of proficiency in metallurgical science." The first award will be made at the end of June, 1883, and will depend in part on an essay on some given subject, partly on a written examination on the metallurgical lectures, and partly on work done in the laboratory. The subject appointed for the essay for 1883 is the "Manufacture of Steel, suitable for Ship and Boiler Plates." It must be illustrated with freehand sketches and mechanical drawings to scale, and must be sent in to Prof. Huntington not later than June 30th next. The competition is open to matriculated students who have studied in the Applied Science Department for at least two years, and who have subsequently made metallurgy a special study.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science) of the Southampton Meeting of the British Association:—

President—Prof. G. D. Liveing, M.A., F.R.S.

Vice-Presidents—A. G. Vernon Harcourt, M.A., F.R.S.; Prof. H. E. Roscoe, Ph.D., LL.D., F.R.S.; F. A. Abel, C.B., F.R.S.; W. Crookes, F.R.S.; Prof. J. Crafts; Prof. De Chaumont, F.R.S.; J. H. Gladstone, Ph.D., F.R.S.; Prof. A. W. Williamson, LL.D., F.R.S.; W. Weldon, F.R.S.

Secretaries—Harold B. Dixon, M.A.; Prof. P. P. Bedson, D.Sc. (Recorder).

Committee—A. Angell, Ph.D.; Prof. Attfield, Ph.D., F.R.S.; W. Lant Carpenter, B.A.; A. E. Fletcher; D. Howard; Prof. A. K. Huntington; F. Maxwell Lyte; T. H. Rowney; J. Millar Thomson; Prof. Tilden, D.Sc., F.R.S.; V. H. Veley, B.A.

The Papers brought before the Section were as follows:—
F. A. Abel, C.B., F.R.S.—On the Legal Flashing Test for Petroleum.

H. B. Dixon—The Influence of Aqueous Vapour on the Explosion of Carbonic Oxide and Oxygen.—A Lecture Experiment.

H. B. Dixon—The Velocity of Explosion of Carbonic Oxide and Oxygen with varying quantities of Aqueous Vapour.

Prof. J. Crafts—On the Boiling-points and Tension of Vapour of a number of Organic Substances determined with the Air-Thermometer.

Prof. Divers and Marachika Shimost—On the Occurrence of Tellurium and Selenium in Japan.

Prof. A. K. Huntington—Report of the Committee on the Photographing of the Ultra-Violet Spark-Spectra emitted by Metallic Elements and their Combinations.

Dr. Marshall Watts—Report of the Committee for the Preparation of Tables of Wave-lengths.

Prof. von Baumhauer—On the Application of the Diamond to Mineralogical and Chemical Analysis.

J. M. Thomson—On the Action of Component Salts as Nuclei on Supersaturated Solutions of certain Compound Salts.

Prof. J. M. Crafts—On the Decomposition of Potassium Chlorate.

Prof. W. A. Tilden, D.Sc., F.R.S.—Hydrocarbons of the Formula $(\text{C}_5\text{H}_8)_n$.

C. T. Kingszett—On the Activity of Oxygen and the Mode of Formation of Hydrogen Dioxide.

Prof. Y. Sakurai—Metallic Compounds containing Bivalent Hydrocarbon Radicals. Part 3.

Prof. Rücker—Report of the Committee on the Methods employed in the Calibration of Mercurial Thermometers.

Prof. Schuster, Ph.D., F.R.S.—Report of the Committee on Spectrum Analysis.

Prof. Liveing, M.A., F.R.S., and J. Dewar, M.A., F.R.S.—On the Reversal of the Spectral Lines of Metals.

C. W. Siemens, D.C.L., F.R.S., and Prof. A. K. Huntington.—On the Electric Furnace.

A. G. Vernon Harcourt, M.A., F.R.S.—The Aerothermometer, an instrument for correcting the Measurement of a Gas.

Charles T. Heycock, B.A.—A Revision of the Atomic Weight of Rubidium.

W. Marriott—On a Method of obtaining Ammonia from Shoddy and Allied Substances.

TO CORRESPONDENTS.

D. L.—Apply to the Secretary, Royal College of Chemistry, South Kensington.

"Cyanures."—The "white paste" referred to in our review of Slater's "Manual of Colours and Dye Wares" is tin sulphocyanide.

T. B.—Radiometers have already been made with one side of the vanes coated with a phosphorescent powder. Persevere and try the experiment for yourself.

THE CHEMICAL NEWS.

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ON THE ORIGIN AND FORMATION OF THE DIAMOND IN NATURE.

By A. B. GRIFFITHS, F.C.S.,
Medallist in Chemistry and Botany.

In this short note the author is desirous of pointing out that we can theoretically account for the formation of crystallised carbon in nature; although scientific men generally hold the opinion that the "origin of the diamond is entirely unknown." We know that the diamond has been found in a fine-grained sandstone in Brazil, and is principally found in an alluvial matrix of sandstone and quartz pebbles. Knowing these facts and that there are only three methods by which crystals are formed, namely, by fusion, by solution, and by sublimation; and as the diamond has been found in sedimentary rocks, and in an alluvial matrix of sandstone and pebbles; and knowing that sandstone and pebbles are produced by the action of water, hence their name of aqueous rocks; and as aqueous or sedimentary strata are often fossiliferous, we may draw an inference that the carbonaceous matter of the fossils (plant and animal remains) has been dissolved by highly heated water aided by great pressure existing in the crust of the earth.

It is a well-known fact that highly heated water aided by pressure can dissolve silica, as in the Geysers of Iceland, &c., where it is deposited round the mouth of the vent forming "the sinter" and also we have the experimental researches of De Senarmont (*Ann. de Chimie*, III., xxxii., 129), and others on the artificial production of crystallised minerals, as quartz, mispickel, corundum, heavy spar, &c., by the prolonged action of water at high temperatures and pressures; and I think we can see no reason why highly heated water or water gas should not have the power of dissolving the carbonaceous matter of fossiliferous plants and animals, and then on cooling depositing the carbon in the crystallised condition forming the gem known as the diamond. As to whether the diamond was formed by sublimation we can draw no inferences from facts or from nature; so must put this method of forming crystals on one side, as not being able to solve the problem; and further, the diamond cannot be formed by fusion, because we know that crystallised carbon in the form of graphite is formed by fusion (as "kish" in the manufacture of pig-iron).

Therefore, it appears from these views on the subject that the diamond has been formed in nature by the solvent action of highly heated water or water gas aided by enormous pressure on the carbonaceous matter of fossils contained in sedimentary rocks followed by slow cooling.

THE PROCESSES OF MM. A. CLASSEN AND A. VON REISS FOR THE DETERMINATIONS AND SEPARATIONS OF METALS BY THE ELECTROLYTIC METHOD.

Report by V. FRANKEN.

SINCE the discovery of the process for the electrolytic determination of copper, various chemists have sought to utilise this simple and elegant method for the determination of other metals. Whilst in the attempts made hitherto the separation of copper succeeds best in a nitric solution, an ammoniacal solution is employed for

the precipitation of nickel and cobalt, and a solution in potassium cyanide for zinc and cadmium. The exactitude of the results depends on strict observance of the conditions which we shall explain.

For instance, the precipitation of copper gives quantitative results only if the proportion of nitric acid in the solution is exactly that which has been established: the precipitation of cobalt and nickel is successful only if a determinate quantity of ammonia and ammonium sulphate has been employed. The electrolytic solution of the chlorides has not been hitherto directly practicable, so that it was first necessary to transform them into sulphates. Except the well-known separation of copper from the metals which are not precipitable in a nitric solution, and from those which are conveyed to the opposite electrode in the state of peroxides, the electric current has not yet been applied as a means of elimination in quantitative analyses. As will be seen below, copper, zinc, nickel, cobalt, iron, manganese, bismuth, tin, cadmium, whether existing as sulphates, chlorides, or nitrates, may be precipitated much more quickly and simply than they have been hitherto, and some of these metals may also be separated in one and the same solution.

Determination of Cobalt.

If we add to the solution of a salt of cobalt an excess of neutral potassium oxalate, and if the clear solution of oxalate is submitted to electrolysis, the intense red colour soon passes to a deep green, which becomes gradually feebler as the cobalt is deposited in the metallic state at the negative electrode. The potassium oxalate is converted into carbonate by the current, and by degrees there is deposited along with the metallic cobalt a precipitate of cobalt carbonate. This precipitate is dissolved by adding cautiously oxalic or dilute sulphuric acid, and the whole of the cobalt is separated by the continued action of the current until the liquid again becomes alkaline.

The electrolytic separation of the cobalt proceeds much more rapidly if the potassium oxalate is replaced by ammonium oxalate, which forms with the compounds of cobalt a double salt readily soluble, and if care is taken to add merely as much ammonium oxalate as is necessary to form the double salt of cobalt. There is deposited along with metallic cobalt a red insoluble cobalt oxalate, which is only slowly reduced by the current. To prevent this separation, the liquid, to which has been added ammonium oxalate in excess, is heated, and 3 to 4 grms. of solid ammonium oxalate are further dissolved. The boiling solution, when exposed to the influence of the current, deposits the cobalt in the form of a grey adhesive coating. By this process, with two Bunsen elements, about 0.2 gm. of cobalt may be separated in the course of an hour. When the reduction is complete (which may be ascertained most simply by adding ammonium hydrosulphate to a small sample of the liquid taken out with a capillary tube), the positive electrode is withdrawn from the liquid which is decanted off, and the precipitate is washed several times with water, then with alcohol, and finally with absolute ether. The residue of cobalt is then dried in an air-bath at 100°, and in a few minutes gives a constant result.

Determination of Nickel.

We proceed precisely as in the determination of cobalt; i.e., we add to the solution ammonium oxalate in excess, heat, and add further about 4 grms. of the solid salt. The separation of nickel is effected as rapidly as that of cobalt: the nickel is deposited in a grey compact stratum, which, remains firmly attached to the electrode.

Determination of Iron.

The authors have used in these assays a solution of chloride and a solution of sulphate, and have proceeded exactly as above. The electrolysis goes on perfectly without separation of any compound of iron if there is present a sufficient quantity of ammonium oxalate.

iron separates out in a brilliant mass of a steel grey colour firmly attached to the platinum. The reduced iron may be exposed for days to the air without any perceptible oxidation.

Determination of Zinc.

Zinc is separated from its solution as a double salt as easily and as rapidly as the preceding metals. The reduced zinc has a dark grey colour, and remains very firmly attached to the electrode. The separated metal cannot be dissolved by heating with dilute acids: in general it appears as a dark coating, which can be detached only by heating the capsule to redness, and treating the residue afresh with acid.

Determination of Manganese.

It is known that manganese can be separated as peroxide from a solution to which nitric acid has been added. But, according to the author's experiments, the precipitation is complete only when the quantities employed are small, when but little nitric acid is used, and when the rinsing takes place without interruption of the current. If the manganese is converted into a soluble double compound by the introduction of an excess of potassium oxalate, and if the solution is then electrolysed, all the manganese is precipitated at the positive electrode. If ammonium oxalate is employed the precipitation is not quantitative. The peroxide separated is not firmly attached to the electrode. Hence it is separated by filtration and transformed into Mn_2O_4 by heating.

Determination of Bismuth.

This assay presents some difficulty. We do not succeed in separating the metal as a compact mass adhering to platinum, and the bismuth is always obtained in the same state whether it is precipitated from an acid solution from the solution of a double salt of ammonium and of oxalic acid, or from a solution to which potassium tartrate has been added. If we give the platinum the greatest possible surface, and fill the capsule to the brim, we may, with a small quantity of bismuth, effect the rinsing in water, alcohol, and ether without loss. If in this operation particles of metal are detached from the capsule, they must be collected on a weighed filter and determined separately. In these assays we add to a nitric solution of bismuth a sufficient excess of ammonium oxalate. In the electrolytic decomposition we observe at the positive electrode a precipitation of peroxide, which slowly disappears. To preserve the reduced metal from oxidation it is necessary to remove the last traces of water by an abundant washing with alcohol and anhydrous ether.

Determination of Lead.

In a nitric solution lead behaves like manganese. When the quantity of peroxide separated is so considerable that it no longer remains firmly attached, and when it passes mechanically to the negative electrode, we cannot effect the determination without considerable loss resulting from the re-solution of the peroxide. The results are very uncertain.

If we submit the double oxalate to electrolysis all the lead present is indeed deposited in the state of metal, but it is so quickly oxidised on exposure to the air that it is rarely possible to dry it without change, even in a current of coal-gas. The electrolytic determination of this metal cannot therefore be recommended.

Determination of Copper.

Copper is separated very rapidly and easily from the double salt which it forms with ammonium and oxalic acid if only a sufficient quantity of ammonium oxalate is added. Weak currents cannot be used for the determination of considerable quantities of copper, as in this case the metal does not attach itself firmly enough to the electrode. The authors employ a strength of current corresponding to about a development of 330 c.c. of gas hourly, and

can separate 0.15 grm. metallic copper in about twenty-five minutes.

Determination of Cadmium.

If the double oxalate of ammonium and cadmium is electrolysed, we obtain the cadmium in the form of a grey coating, which though not adhering very firmly to the electrode undergoes no loss if washed with caution.

Determination of Tin.

Tin can be very well determined electrolytically. It separates either from a hydrochloric solution or from the solution of a double ammonium oxalate in the state of a fine grey coating. If we use the potassium salt instead of ammonium oxalate, the electrolysis presents difficulties, for there appears at the opposite pole a basic salt which is not reduced. If the tin is separated from an acid solution the current must not be interrupted during rinsing—a precaution not necessary when employing the ammonium oxalate. When the tin is detached from the platinum capsule it presents phenomena similar to those described under zinc. As a general rule there remains a black residue on the electrode.

Determination of Antimony.

In a hydrochloric solution antimony is precipitated in the metallic state, but not firmly attached. If to the solution of trichloride we add potassium oxalate the antimony is easily reduced, but the metal is still not attached firmly to the electrode. A firmly adhesive coating may be obtained by the addition of an alkaline tartrate, but the separation takes place too slowly.

The precipitation of antimony succeeds very well in a solution of its sulpho-salts. We add hydrogen sulphide to the solution, which may contain free hydrochloric acid; we neutralise with ammonia, and add ammonium hydro-sulphate in excess. The reduction is accelerated by the addition of a little ammonium sulphate. The antimony is separated at the electrode as a fine light grey precipitate, firmly attached if the precipitation has not been hastened by the use of too strong a current. When the reduction is complete the liquid is decanted off, and the residue cleaned in the ordinary manner.

Determination of Arsenic.

Arsenic cannot be separated quantitatively either from an aqueous or a hydrochloric solution, or from one to which ammonium oxalate has been added.

In the aqueous solution, as well as in the oxalic, a part of the arsenic is reduced to the state of metal, whilst in the hydrochloric solution it is all volatilised as arsenamine if the action of the current is sufficiently prolonged.

Separation of Iron and Manganese.

The separation of the two metals is only possible by preventing the formation of manganese peroxide until the greater part of the iron has been precipitated. We effect this object by the addition of sodium phosphate or more easily by the addition of a large excess of ammonium oxalate.

In both cases there appears, under the influence of the current, the characteristic colouration of permanganic acid, which disappears afterwards at the negative electrode. When the greatest part of the ammonium oxalate has been transformed by the current into ammonium carbonate, the colour becomes permanent in consequence of the formation of manganese peroxide. We add, in the outset, ammonium oxalate to the liquid, apply heat, dissolve further 3 or 4 grms. ammonium oxalate in the liquid, and electrolyse at once. The separation of the two metals takes place immediately and exactly, especially if the quantity of manganese is small. It appears as peroxide at the positive electrode, whilst the iron is deposited at the negative. If the proportion of the manganese is more than double the quantity of the iron, the precipitation of the latter will last longer. It is then

necessary, in order to effect a complete separation, to re-dissolve the deposit of peroxide in oxalic acid, adding the latter without interrupting the current, so long as the liquid has a red colour.

In separating the two metals the authors find it useful not to apply too strong a current (2 Bunsen elements are sufficient), and not to reinforce it unless compelled in consequence of too large a quantity of manganese, so as to re-dissolve the peroxide. When the assay is concluded it is not prudent to let the current act, as then a little peroxide is deposited very firmly upon the iron, and must be dissolved off in oxalic acid, after decanting off the liquid, or the electrolysis must be repeated. As we have already remarked in treating of the determination of manganese as peroxide, the precipitation of this metal from a solution of ammonium oxalate is not quantitative. We must therefore boil the liquid which holds in suspension the greater part of the manganese in the state of peroxide, so as to decompose the ammonium carbonate. The rest of the ammonia is then neutralised with nitric acid, and the manganese is transformed into sulphide by the addition of ammonium hydrosulphate. The manganese sulphide is strongly heated in a current of hydrogen and weighed directly.

Separation of Iron and Aluminium.

This separation, which offers serious difficulties by the ordinary methods, is easily effected by electrolysis. If we submit to electrolysis a solution (of ammoniacal oxide of iron and of aluminium ammoniaco-oxalate), to which a large excess of ammonium oxalate has been added, the iron is separated first as a coating firmly attached to the negative electrode, whilst the aluminium remains in solution as long as the quantity of ammonium oxalate is greater than that of the ammonium carbonate formed. If there is ultimately produced a precipitate of alumina the solution is then almost entirely free from iron. A few drops of the liquid holding the aluminium in solution are tested from time to time with ammonium hydrosulphate to find if iron remains and the current is interrupted as soon as no reaction is produced.

To make the determination we add ammonium oxalate in excess to a neutral or slightly acid solution. We may also, if needful, neutralise with ammonia. We add further ammonium oxalate in the proportion of 2 or 3 grms. per 0.1 grm. of oxide, and the hot solution is immediately electrolysed. The current must not be allowed to act until all the aluminium is precipitated along with the iron. A part of the aluminium would then adhere to the iron so that it could not be detached. Then, as it has been said with reference to the separation of manganese, the iron must be re-dissolved in oxalic acid, the liquid containing the aluminium having been previously decanted and the electrolysis repeated.

In order to precipitate completely the alumina from the liquid which has been freed from iron we add ammonia, heat for some time, and proceed in the ordinary manner. If the quantity of alumina is not greater than that of iron this method gives immediately accurate results. In the contrary case the precipitate of aluminium is dissolved and electrolysed again, adding oxalic acid cautiously and not interrupting the current.—*Revue Universelle des Mines.*

Elasticity of Rarefied Gases.—E. H. Amagat.—At the lowest pressures which have been experimentally reached (two-tenths of a millimetre) there does not appear to be produced any abrupt change in the law of the compressibility of gases; they still follow the law of Mariotte. It may certainly occur that a sufficient rarefaction, acting like a great elevation of temperature, may cause gases to follow the law $p(v-a)=c$, as in the case of hydrogen; but it is far from this to the limit of which M. Mendeleeff and M. Siljerström, a state in which gases become infinitely little compressible.—*Comptes Rendus.*

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING JULY 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOFF TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

August 3rd, 1882.

SIR,—We submit herewith the results of our analyses of the 181 samples of water collected by us during the month of July, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 181 samples, two were recorded as slightly turbid, and five as very slightly turbid. The remainder were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from July 1st to July 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, three were recorded as "very slightly turbid," and one as "slightly turbid." The remainder were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, one was recorded as "very slightly turbid," the remaining 25 samples being found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, one was recorded as "very slightly turbid," and one as "slightly turbid," the remaining 24 samples being well filtered, clear, and bright.

Of the 25 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be observed that, despite the storms so frequent during the month, the general degree of freedom from turbidity of the water, though less complete than that which was noticeable throughout the two preceding months, was, on the whole, very satisfactory; while in respect of colour, aëration, and freedom from excess of organic matter, the previous excellent condition of the water was fully maintained.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOFF TIDY.

THE DETERMINATION OF ORGANIC MATTER
IN POTABLE WATER.*By Prof. J. W. MALLET, F.R.S., University of Virginia.
(Concluded from p. 102.)*Biological Results as to Animal in Contrast with Vegetable
Organic Matter in Water.*

1. Decidedly the most noteworthy result under this head is the well marked pathological effect produced upon rabbits by the injection of waters contaminated solely by such vegetable matter as would usually be esteemed harmless. An account has been given on previous pages of the general report of the repeated experiments, with water containing an infusion of dead forest leaves (No. 68), all leading to essentially the same result. A like effect followed from the experiments with the peaty waters of the Dismal Swamp (Nos. 78 and 79).

While there have hitherto been occasional allusions by sanitary writers† to slight indisposition now and then experienced by persons drinking the peat water of mountain streams, it has been usually assumed that peaty water is *not* unwholesome, strong language on this head being often used,‡ and that, in general, organic matter of vegetable origin is harmless, or comparatively harmless, while that of animal origin is highly dangerous.§ The results above referred to indicate that, under the special conditions of the experiments with rabbits, vegetable matter representing mainly or largely alteration products of woody fibre may be in a high degree pernicious.

2. It will be seen that for nearly all the waters classed as "dangerous" by Professor Martin and Dr. Hartwell the ratio of organic C : N was rather high.

3. The above conclusion as to the apparent possibility of vegetable organic matter proving itself decidedly injurious has to be qualified by observing that in the well marked cases of such results the amount of organic matter present in the water was large, and it would not be safe to affirm on this evidence alone, that similar waters, if diluted to the ordinary potable standard,|| would still prove themselves capable of causing disease or death in the animals experimented on; indeed, the evidence tends rather the other way, so far as the experiments go which were made by injecting the rabbits with *the same quantities* of weaker solutions. But, on the other hand, water containing as much vegetable organic matter as No. 78 is often used for drinking purposes in peaty districts, and this very Dismal Swamp water has often been taken by choice as the supply for ships leaving port, and has been spoken of as a source of supply for the city of Norfolk; so that the discussion of wholesomeness or unwholesomeness of such water is not without practical interest.

4. If the theory be accepted, which has so much in its favour, attributing the production of disease by organic matter in drinking-water not to any specifically poisonous *substance* or substances, but to the presence and action of living organisms, it seems quite conceivable that a water containing organic matter of any kind, including vegetable matter, may be harmless at one time, and harmful at another, when perhaps a different stage of fermentation or putrefactive change may have been entered upon, and special organisms may have made their appearance or entered upon a new phase of existence. Thus there might

possibly be safety in drinking a peaty water, or water filtered through beds of dead forest leaves, when fresh, danger when after a certain amount of atmospheric exposure bacterial organisms had become developed, and safety again, perhaps, after the growth of such organisms had fallen off and more or less of the available organic matter had been consumed. I have been informed that old ship-captains who have often carried the water of the Dismal Swamp to sea entertain a belief that this water undergoes a "kind of fermentation," after which it becomes remarkably good and wholesome. In support of some such idea as to different stages passed through by a water (containing vegetable matter) as to the development of organisms and sanitary character, leading to the possibility, on its being stored, of wholesomeness at one time and unwholesomeness at another, the microscopical and biological reports of Nos. 62, and 69, 70, and 71, are worthy of notice.

*Evidence Afforded by Chemical Results as to Putrescent or
Non-Putrescent Character of Organic Matter in Water.*

1. Tidy has claimed* as one of the merits of the permanganate process, that it enables the distinction to be drawn between "putrescent and easily oxidisable" and "non-putrescent or less easily oxidisable" organic matter, and has given the results of some experiments to show that the former are, for the most part at any rate, disposed of within the first hour; hence his rule as to determining separately the consumption of oxygen in that time and in three hours, and comparing the results, by means of which comparison he says "we obtain data of great value by which to judge the nature of the organic impurity." In column 28 of Table X., I have given the ratio of the consumption of oxygen from permanganate used as directed by Tidy in 1 hour to that in 3 hours, the latter quality assumed = 100. The results for those waters, the nature of the organic matter in which was known, are obviously affected variously by sundry conditions, such as the different strengths of solutions, the presence together of both easily and less easily oxidisable matter, &c., but on the whole do not afford much support to the opinion expressed by Tidy. He distinctly assumes animal matter to be, at any rate as a rule, more "putrescent and easily oxidisable" than vegetable matter, but on examining the percentages in column 28, taking the averages for the different classes of waters, we find—

	Per cent.
Organic matter of vegetable origin :	
For Class IV.	84.0
For Class V.	80.8
Organic matter of animal origin :	
For Class VI.	74.5
For Class VII.	77.6
For Class VIII.	79.0

Thus, although the differences are not very great, the proportionate consumption of oxygen within the first hour is rather greater for those waters containing vegetable than for those containing animal matter. Again, judging merely by appearance, smell, &c., I should say that the waters in the foulest and most actively putrescent condition were those containing the alkaline washings from a starch factory (Nos. 89, 90, 91), the washings from the bag-filters of a sugar refinery (Nos. 92, 93, 94), the refuse from canning tomatoes (Nos. 98, 99, 100), infusion of human faecal matter (Nos. 104, 105, 106), infusion of the body of a dead animal (Nos. 119, 120, 121), mixed drainings from a slaughter-house (Nos. 125, 126, 127), and the dejecta from typhoid fever patients (Nos. 137, 138; the average consumption of oxygen for all of these in one hour is 80 per cent of that in three hours; almost exactly the same with the mean of all the above figures for the five classes examined (giving them equal value), viz., 79.2 per cent.

2. On the other hand, Dr. Smart has expressed the opinion, based upon his previous extensive experience with

* Preliminary Report on the results of an investigation, made by direction of the National Board of Health, as to the chemical methods in use.

† Angus Smith, in CHEMICAL NEWS, June 25, 1869; 304. Ekin, "Potable Water," p. 15; foot-note. 6th Report of Pollution of Rivers Commission. . . 34.

‡ Tidy, *Jour. Chem. Soc.* (Lond.), Jan., 1879; 65. Ekin, "Potable Water," p. 15.

§ Frankland, "Water Analysis," 93-97. Tidy, *Jour. Chem. Soc.* (Lond.), Jan., 1879, 80-83. Ekin, "Potable Water," pp. 12, 13, 14, 15, &c. K. Haines, "Methods for Judging of Wholesomeness of Drinking Waters," p. 11. De Chaumont, *Arch. Ch. Pharm.*, xvii., 124.

|| See Sixth Report of Pollution of Rivers Commission, p. 54.

the albumenoid-ammonia process, aside from his work with it in connection with the present investigation, that gradual evolution of albumenoid-ammonia indicates the presence of organic matter, whether of vegetable or animal origin, in a fresh, or comparatively fresh, condition, while rapid evolution indicates that the organic matter is in a putrescent or decomposing condition. In column 45 of Table X. will be found his application of this principle of interpretation to his results obtained from the waters examined; the detailed facts as to the rate of evolution of albumenoid-ammonia in the measures of distillate successively collected will be found in Appendix D. It will be seen that in a very large proportion of the cases before him Dr. Smart has interpreted correctly the general character of the water as to putrescence or comparative freshness of condition of the organic matter. Examples, however, of erroneous results from this principle of interpretation are furnished by Nos. 77, 92, 93, 94, 125, 128, and 131, nearly all of which, it may be observed, were very dilute liquids, and perhaps by the waters (Nos. 113, 114, 116, 117, and 118) containing mixed sewage from Richmond and Washington, though these, also quite dilute, can hardly be quoted as examples involving a known degree of putrescence on the part of the organic matter.

Biological Results in connection with Putrescent or non-Putrescent Character of Organic Matter in Water.

On the whole the biological results obtained, taken in connection with the history and condition of the water samples in which the nature of the organic matter was known, are in accordance with the general belief that putrescent organic matter is more dangerous than that in a fresh or but slowly decomposing condition. Taking the twenty waters which have been noticed above, as containing the most obviously foul, evil smelling, and actively putrescent material, in some of vegetable, in others of animal origin, and comparing these with the lists of waters, as classified by Professor Martin and Dr. Hartwell, we find nine classed as "dangerous," and seven as "suspicious"; of the remaining four, the fact that two represented the weakest dilutions of materials, which in stronger solutions produced marked pathological effects, deserves to be noticed.

GENERAL CONCLUSIONS, WITH A VIEW TO SANITARY APPLICATIONS AS TO THE VALUE, SEPARATELY AND COLLECTIVELY, OF THE DIFFERENT PROCESSES OF WATER ANALYSIS WHICH HAVE BEEN UNDER EXAMINATION.

1. It is not possible to decide absolutely upon the wholesomeness or unwholesomeness of a drinking-water by the mere use of any of the processes examined for the estimation of organic matter, or its constituents.
2. I would even go further, and say that, in judging the sanitary character of a water, not only must such processes be used in connection with the investigation of other evidence of a more general sort, as to the source and history of the water, but should even be deemed of secondary importance in weighing the reasons for accepting or rejecting a water not manifestly unfit for drinking on other grounds.*
3. There are no sound grounds on which to establish such general "standards of purity," as have been proposed, looking to exact amounts of organic carbon or nitrogen,

* It will not do merely to throw all doubts on the side of the rejection of a water, as has been more or less advocated by writers on water analysis, for there are often interests of too serious character involved in such rejection to admit of its being decided on, save upon really convincing evidence of its necessity. In view of the great and increasing difficulty of securing an adequate supply of water of satisfactory character for very large cities, is it an impractical fancy that there may yet come to be provided a double supply through separate pipes; 1st, of water for drinking and cooking purposes only; and 2nd, of water less carefully selected as to source and storage for bathing, washing, house and street cleaning, extinguishing fires, &c., the former at any rate dispensed through meters to regulate consumption?

"albumenoid ammonia," oxygen of permanganate consumed, &c., as permissible or not. Distinctions drawn by the application of such standards are arbitrary, and may be misleading.

4. Two entirely legitimate directions seem to be open for the useful examination by chemical means of the organic constituents of drinking water, namely, first, the detection of very gross pollution, such as the contamination of the water of a well by accidental bursting or crushing of soil-pipes, extensive leakage of drains, &c., and secondly, the periodical examination of a water supply, as of a great city, in order that, the normal or usual character of the water having been previously ascertained, any suspicious changes which from time to time may occur shall be promptly detected and their cause investigated.

5. In connection with this latter application of water analysis, there seems to be no objection to the establishment of local "standards of purity" for drinking water, based on sufficiently thorough examination of the water supply in its usual condition.

6. With the facts of this investigation before me, I am inclined to attach special and very great importance to a careful determination of the nitrites and nitrates in water to be used for drinking.

7. If I had entrusted to me the charge of watching a large city water supply I should use all three of the principal processes for the examination of the organic matter present; each gives a certain amount of information which the others do not afford.

Under circumstances admitting only of the use of simpler means of investigation, the albumenoid ammonia and permanganate processes might be employed together, but in no case should one only of these methods be resorted to, such a course entailing practically the neglect of carbon on the one hand or nitrogen on the other.

PRACTICAL SUGGESTIONS DRAWN FROM THE EXPERIENCE OF THE INVESTIGATION NOW REPORTED ON AS TO THE USE IN THEIR PRESENT FORM OF THE CHEMICAL PROCESSES STUDIED.

Examination of Water Samples in General.

1. Great care should be taken that water samples be placed in the hands of the analyst and their examination begun with the least possible delay after they have been collected. The changes which take place, sometimes rapidly, on keeping, may seriously affect the results, especially in the case of waters much polluted by foul organic matter.

2. It is very desirable that, besides examining a water in its perfectly fresh condition, samples of it should be set aside, in half-filled but close glass-stoppered bottles, for some time—say 10 or 12 days—and one of these examined every day or two, so as to trace the character and extent of the changes undergone. Not only may conclusions be drawn from such a series of observations as to the general stability or decomposability of the organic matter present, but light will be thrown upon the changes which may be expected to occur under ordinary conditions when the water is stored for use, as in cisterns, wells during periods of drought, or carelessly allowed to remain stagnant in pitchers, water-coolers, &c.

Combustion Process.

1. In applying this process, no matter how skilled or well trained the analyst may be, duplicate or even triplicate concordant results should be insisted upon before accepting the determinations as trustworthy.

2. In order to avoid the presence in the atmosphere, about the water-bath used for the evaporation, of ammonia derived from coal-gas, the bath should be heated by steam

* Dr. J. S. Billings, U.S.A., of the National Board of Health, has suggested to me in conversation a useful subject of inquiry, viz., the possibility of tracing up the passage of polluting material through a soil by bleaching samples of the soil itself, taken at various distances from the source of pollution, or from the water likely to be affected and chemically examining the liquids obtained.

brought in a small, closed pipe from a distant boiler, preferably situated in another room, and the waste steam and condensed water therefrom should be in like manner carried off to a safe distance.

Albumenoid-Ammonia Process.

1. In order to avoid the uncertain ending of the collection of ammonia, whether "free" or "albumenoid," it would be well to adopt the rule that the distillation be stopped when, and not before, the last measure of distillate collected contains less than a *certain proportion*—say one per cent—of the whole quantity of ammonia already collected. This would in many cases involve the necessity of replenishing the liquid contents of the retort with ammonia-free water.

2. In order to diminish the loss of amines or other volatile forms of nitrogenous matter, a separate distillation should be made with alkaline permanganate added *at once*, in addition to the usual course of treatment prescribed by Wanklyn—distillation begun with sodium carbonate, and continued after addition of the alkaline permanganate. The results of the two separate distillations should then be compared.

3. In reporting the results obtained by the albumenoid-ammonia process, including the determination of free ammonia, the details of the evolution of ammonia, as collected by separate measures of distillate, should always be given.

Permanganate Process.

1. In view of the evidence obtained rendering probable the loss of organic matter by volatilisation in the use of acidified permanganate at a boiling temperature, the Tidy form of the process is rather to be recommended than that of Kubel if but one be used.

2. On the other hand, the advantage of more extended oxidising action, and the greater *general* accordance of the results by the Kubel process with those for organic carbon by the combustion process, make it desirable that as far as possible the same advantages should be secured by substituting the influence of time for that of temperature, and that the time during which the permanganate is allowed to act in the Tidy process should be increased to at least 12, better to 24, hours, *several* determinations (on different samples set aside at the same time) being made at such intermediate intervals as 1, 3, 6, 9, and 12 hours, in order to trace the progress of the oxidation.

SUGGESTIONS AS TO POSSIBLE IMPROVEMENTS ON THE PROCESSES EXAMINED DESERVING FURTHER INVESTIGATION.

Combustion Process.

1. I would propose to evaporate the water, not under ordinary pressure and in contact with the atmosphere, as usual, but as the specimens of water were evaporated for the biological experiments, in a closed vessel immersed in a water-bath and connected with a good (water jet) air pump, so as to secure a nearly complete removal of air, with a condensing worm to dispose in part of the aqueous vapour given off. It would not do to simply place the water in a flask, since the residue could not be removed for combustion, but it would not be difficult to arrange a suitable vacuum vessel, with wide mouth and tightly clamped on cover, within which might be placed the usual glass dish to receive the water, and the feed might be managed through a nearly capillary tube with a glass stop-cock. By such an arrangement the evaporation might be effected within a moderate time at a fixed temperature much lower than the boiling point, thus probably reducing any loss from simple volatilisation of organic matter; the nearly complete exclusion of air would tend to greatly diminish or do away with loss of organic matter by oxidation, and permit of large reduction in the quantity of sulphurous acid used; for the same reason the tendency to formation of sulphuric acid would be reduced to a minimum, and the absorption of ammonia from the atmosphere about the dish would be altogether prevented. In testing

this last-named effect, two bulb-tubes containing pure sulphuric acid might be interposed between the vacuum chamber and the pump; the contents of the one to be tested for ammonia given off from the water, those of the other to guard against any trace of ammonia coming back from the outside air during irregular action of the stream of water.

2. In order to avoid loss during the evaporation of readily volatile substances, such as butyric, valeric, &c., acids, to dispense with the necessity for the uncertain and unsatisfactory correction for ammonia lost by dissociation, to get rid of the influence on the determination of organic nitrogen of any errors in the determination of the total ammonia, and to avoid corresponding difficulties arising from the presence of nitrates if these be allowed to remain, it might be well to evaporate at first with the addition of a small excess of magnesia (as recommended by Lechartier), thus removing all ammonia, and then, the water having been brought down to a small volume, add a moderate excess only of sulphurous acid* with a drop of a solution of a ferrous salt (as directed by Frankland), and complete the evaporation to dryness—the whole process to be carried out in a jet-pump vacuum, as above suggested.

3. Further experiments are desirable in order to completely determine the merits and defects of the Williams ("copper-zinc couple") method for the removal of nitrates.

4. Some preliminary experiments of my own seemed to show that nitrates and nitrites may be completely reduced by evaporating to a small bulk with no great excess of phosphorous or hypo-phosphorous acid, guarding against the evolution of phosphuretted hydrogen by the low temperature employed, then adding magnesia in small excess and completing the evaporation, thus leaving the residue in a pulverulent instead of sticky condition, easy of removal from the dish, and probably allowing of complete combustion without inconvenience from the final oxidation of the small excess of phosphite or hypophosphite, and without any wrapping up of carbon particles. This plan deserves to be carefully tested.

Albumenoid-Ammonia Process, Including Determination of Free Ammonia.

1. In order to prevent, or at least to largely reduce and render uniform, the loss of ammonia from imperfect condensation, I would prefer to effect the distillation, not by a lamp-flame, but in a retort of uniformly determined shape and size, uniformly immersed in a bath of saline solution or other suitable material kept at a uniform temperature—say 12° or 105° C.—by means of steam, and to condense in a glass worm, surrounded by ice-water, sufficiently long to bring the distillate to a uniform temperature, not exceeding, say, 5° C.

2. It would be perhaps still better to conduct the distillation in a completely closed apparatus, with a fixed difference of temperature between the retort and the far end of the fully effective condensing tube, with a glass stop-cock to draw off the distillate in successive measured portions, and a little safety-valve (mercury or other) near the cold end to prevent any dangerous difference of external and internal pressure.

3. In the determination of *free* ammonia, with a view to distinguishing as sharply as possible between ammonia really existing as such or in ammoniacal salts and that found by breaking up of organic matter, it might be well to try a closed distilling apparatus connected with a (water-jet) air-pump, so as to maintain a partial vacuum within, keeping the retort at a fixed temperature much below 100° C. and collecting the whole of the ammonia in a flask and one or more bulb tubes containing rather weak mineral acid, interposed between the condenser and the pump. This would, however, be attended with the disadvantage of not readily permitting the progress of the evolution of ammonia to be traced by its collection in separate succes-

* I doubt, however, the possibility of fully reducing nitrates, by means of sulphurous acid, if they are present in large quantity.

sive measures of distillate; and it would become necessary to ascertain whether the application of the Nessler test would be in any way interfered with by the sodium salts formed from the acid used to collect the ammonia.

4. In order to overcome, if possible, the most serious difficulty in the way of a correct determination of free ammonia, namely, the ready breaking up of urea (and other amides), when present, on heating with sodium carbonate, it would be well to ascertain at how low a temperature and within what time, if at all, ammonia really existing in ammoniacal salts could be completely driven off from an *extremely dilute* solution by adding a small excess of magnesia and maintaining a (water-jet) air-pump vacuum above the liquid, forming a stratum of small depth, with bulb tubes of acid between the liquid and the pump to intercept the ammonia, and guard tubes to prevent any being received from the air; in other words, to ascertain whether Schloesing's method for the determination of ammonia admits of being applied to such excessively minute amounts of it as the water analyst is concerned with.

5. In the conduct of the albumenoid-ammonia process proper, *i.e.*, the distillation with alkaline permanganate, I would propose that the original volume of liquid in the retort be maintained *constant*, by running in at the proper rate, through a nearly capillary tube with a glass stop-cock, ammonia-free distilled water. And, in cases in which the amount of organic matter is so large as to wholly, or in great part, reduce the usual charge of alkaline permanganate, I would determine by a preliminary experiment at about what rate the reagent is used up, and would then progressively supply its solution, instead of simply pure water, at such a rate as to keep the original strength as nearly as possible unaltered.

Permanganate Process.

1. The principle involved in the last paragraph applies also to this process. Instead of using a fixed amount of permanganate at first, and adding a second or third charge only when the former has been completely reduced, there ought to be a fixed excess at the end of the action, or rather there should be present a constant excess all through the process. Hence, when a preliminary experiment has shown that more than the usual charge of permanganate will be needed, and about the rate at which it will be consumed, for the final experiment additional permanganate solution should be gradually dripped in, from a nearly capillary tube, at such a rate as to maintain the original excess as nearly as possible constant.

2. It is desirable that the process be carried on at a pretty nearly fixed temperature.* If the Tidy method be followed, a temperature of say 20° C., could, with a little management, generally be secured, and the flasks kept approximately at this point during the time required for the action.

SUGGESTIONS AS TO FURTHER INVESTIGATIONS IN GENERAL CONNECTION WITH THE SUBJECT-MATTER OF THIS REPORT.

1. It is much to be wished that more extended biological experiments should be made upon the effects of water variously polluted on the lower animals, and that in such experiments the action of water introduced into the stomach as well as hypodermically injected should be tested, and other animals (such as dogs) used as well as rabbits.

2. It would be well to have chemical examinations, on a strictly uniform plan, from time to time made of the water supply in a few of the largest cities at periods when, not mortuary statistics, but the general assent of well-informed members of the medical profession, ascertained through local sanitary authorities, indicates unusual pre-

valence of, or unusual exemption from, the classes of disease most probably capable of origination from the organic pollution of drinking-water.

3. I would *especially* suggest a combined chemical and biological enquiry as to the possible effects upon living animals of the ferment or ferments of nitrification in different stages of that process. In connection with this some minor questions connected with the development of nitrites and nitrates from decomposing organic matter are pointed to, by facts observed in the course of the investigation now reported on, as deserving further examination.

CONCLUSION.—ACKNOWLEDGMENT OF ASSISTANCE RECEIVED.

It remains only for me to record my thanks to the following gentlemen for aid of various kinds, obligingly rendered, in connection with the work which forms the subject of this report:—

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To Mr. Chas. E. Heald, Lynchburg, Va.; The Montague Paper Company, Turner's Falls, Mass.; Mr. Wright

* For experiments on the varying extent of action of permanganate upon organic matter in water at different temperatures, see *Bericht. d. Deutsch. Chem. Gesellsch.*, 14, 1013-1.

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NOTICES OF BOOKS.

Light, a Course of Experimental Optics Chiefly with the Lantern. By LEWIS WRIGHT. With illustrations. London: Macmillan and Co.

WE have here a clearly written and abundantly illustrated manual, apparently designed for the guidance of science teachers. Algebraical formulæ have been avoided, the author seeking to explain the phenomena and the laws of light in a purely experimental manner. In this respect the work occupies an exceptional position among optical treatises, and it will in consequence prove valuable to a certain class of minds who are essentially non-mathematical, but who need not on that account find themselves excluded from a knowledge of the methods and the results of physical science.

The author, in his preface, quotes certain remarks made lately by Prof. Huxley in his capacity as an Examiner in the Science and Art Department. He reiterated, we are told, "a complaint well known at South Kensington as to the great difference between two kinds of what persons called knowledge. That which they had constantly to contend against in the teaching of science in this country was that many teachers had no conception of that distinction; for they thought it quite sufficient to be able to repeat a number of scientific propositions, and to get their pupils to repeat them as accurately as they themselves did." Now, if this difficulty has to be encountered "in this country," more than in any other,—which we neither affirm nor deny—is not the reason that our system of education is more examinational than that of other countries? "South Kensington" should ask itself whether it is not to blame for the complaint which it knows so well.

Mr. Wright seeks in the book before us to teach facts clearly and vividly as the base upon which generalisations have to be founded. As a means of class demonstration, the author in the majority of cases recommends the lantern. He treats successively of this instrument and its accessories, of rays, images, and reflection; of refraction, total reflection, prisms, and lenses; of dispersion, and the spectrum; the nature of light, its velocity, and the undulatory theory; of colour, where he upholds the Helmholtz-Maxwell doctrine of red, green, and violet as the three primary colours; of spectrum analysis; of phosphorescence, fluorescence, and calorescence, in which chapter he duly notes as exploded the notion once entertained of three superposed but independent spectra; of interference, of double refraction and polarisation, of polarising apparatus, of rotatory, circular, and elliptical polarisation, of optical phenomena of crystals in plane and in circularly polarised light; of polarisation and the colour of the sky, and of polarisation by small particles. There are 190 illustrations and diagrams, besides eight plates, and a full and accurate index.

We think that whoever fairly examines this book will agree with us that its teachings are on a level with the most recent position of optical science, and that they are expressed with rare clearness and simplicity.

The work, as we note with pleasure, is not examinational. It is not fitted up with a string of questions which have been or which may be asked at South Kensington, or elsewhere. The student who takes this work as his guide may perhaps fail to "pass," but he will be certain to "know."

The Student's Guide in Quantitative Analysis, intended as an Aid to the Study of Fresenius's System. By H. CARRINGTON BOLTON, Ph.D. New York: John Wiley and Sons. London: Trübner and Co.

THIS little work gives abridged methods for the quantitative analysis of a number of bodies, organic and inorganic, some of them of a very simple nature, such as barium chloride and magnesium sulphate, and others highly complex, such as iron-slag, titaniferous iron-ore, and urine. In the selection of the substances for whose analysis procedures are here laid down, the author seems to have been guided in part by their commercial importance, but in part also by their serving to exercise the student in analytical methods. In no case do we find directions for the determination of any of the rarer elements. The instructions given are brief,—indeed, the author himself speaks of their "fragmentary character,"—but this feature may be accounted for by his peculiar object. The book is intended, not as a substitute for Fresenius, but as a key or guide to the right use of his classical work. There are, also, under almost every heading, references to other works, where the analysis of the substance in question, or the determination of some one of its constituents, is treated of in full. Thus, under Dolomite we have references to Fresenius, to the *Comptes Rendus*, and the *American Chemist*. Under "Silver Coin" Dr. Bolton speaks of a piece of apparatus under a name which will somewhat mystify any English student into whose hands the book may fall. He directs a filtrate to be heated to boiling in a "casserole." From the context he evidently means a "capsule." As "an aid to the study of Fresenius's system," which is what the author intends and professes it to be, this little work will be found useful.

CORRESPONDENCE.

CHEMISTRY AND COURTESY IN GERMANY.

To the Editor of the Chemical News.

SIR,—Perhaps it may interest your readers to know of the kindness and courtesy with which even such English chemical adventurers as myself are treated by men of the greatest reputation, in Germany, who seem for the most part to speak English very fairly. Prof. Kekulé, of Bonn University (to whom I had sent the proof of the article in the *CHEMICAL NEWS*, vol. xlv., p. 33), caused me to be shown over the splendid chemical laboratory there, and suites of rooms belonging to it—the largest in Europe I believe—and then conversed with me about the subject of my paper. He seemed very much struck with the fact which I repeated to him, that an undoubted sodium orange flame (as that produced from *cryolite* before the blowpipe) removes the turbidity caused by the orange flame from platinum in a boric acid bead; as also by the argument I used that, according to Euclid, "the same cause producing exactly opposite results is a *reductio ad absurdum*." He told me that the Bonn course of chemistry is chiefly inorganic, and that the blowpipe is only taught there to beginners.

At Heidelberg, Professor Bunsen (to whom I had also sent a copy of my article) received me with the greatest kindness in his private library, in which I observed a full-length bronze statue of Berzelius. He led me to the sofa

and sat there with me—a mark of regard in Germany, I am told—and when I showed him my air-reservoir blow-pipe and apparatus in a cigar-case, he said, "This is very beautiful,"—I suppose he meant "ingenious"—but he also said, "They did not teach the blowpipe at all there" (!) as it seemed to me, in a tone of regret. He told me "he would come oftener to England but for the horrors of the North Sea."—I am, &c.,

W. A. ROSS.

28, Alexander Strasse, Stuttgart,
August 29th, 1882.

SUGAR ANALYSIS.

To the Editor of the Chemical News.

SIR,—I have noticed a communication from C. A. Crampton in your issue of July 14, 1882, and likewise R. H. Harland's reply two weeks later. The latter gentleman has, I think, given a sufficient answer to the criticism of Mr. Crampton, but I desire to supplement this answer by a few words.

Mr. Crampton states "that mixed starch and sugar do not polarise higher than pure cane sugars, but rather lower." Now as a matter of fact, as Mr. Harland has remarked, the starch sugars of commerce ordinarily used for mixing up to the present time, though some are of snowy whiteness, are *not highly converted*, and according to my experience do not contain on the average above 75 per cent pure dextrose, polarising generally above 100 if the solution is not allowed to stand too long before observation; this polarisation, however quickly, lowers on standing or heating, and may reach 75 after two or three hours. Quite recently there has appeared upon the market here, though not manufactured extensively I believe, a well-crystallised dextrose made from corn starch, which, I take it, is probably 98 per cent pure dextrose; this article can be produced for about one-half the price of white sugar, and will, I fear, be largely used to adulterate the latter, for which purpose its physical properties well adapt it.

However, it is not at all necessary for a cane sugar to be mixed with a high-polarising starch sugar to make the complete analysis add up over 100—which is the test I have proposed in my manual for detecting the presence of starch sugar. A simple numerical calculation will show this plainly. Suppose, to make the case as unfavourable as possible from my point of view, 100 parts of a cane sugar containing 90 parts sugar, 3 parts glucose, and 7 of impurities, were mixed with 5 parts of high grade starch sugar containing 98 per cent dextrose, 2 per cent impurities, and polarising 75. Omitting the figures the mixture would polarise 89.20 and contain—

Dextrose	..	..	..	..	75.2
Impurities	..	..	..	..	6.76

103.48

Thus we see that when the mixture actually polarises *less* than the cane-sugar adulterated, the analysis still adds up over 100, and the reason is not far to seek in the fact, that while the polarisation is only slightly lowered by the grape sugar the amount of dextrose and impurities added is proportionally large so as to bring up the result as we have seen. From my experience in the analysis of these adulterated sugars, I have found the three qualitative tests given in my manual as entirely reliable, and of great value when used according to the limitations which I have plainly pointed out for them; I am not afraid but what chemists of the requisite experience will endorse my position upon the matter.

By a confusion of thought my critic appears to consider that if the mixture polarises less than the sugar adulterated that he has proven his case. It seems hardly possible that he ever could have made a complete analysis of a sample of mixed sugar, and I submit that it has been

clearly proved that he has been writing about a matter he does not understand.

In regard to Mr. Crampton's discourtesy, I think I can afford to let that pass, especially as Mr. Harland has already disciplined him for what is probably only a "youthful indiscretion."—I am, &c.,

J. H. TUCKER, Ph.D.

New York, August 18, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 6, August 7, 1882.

Researches on the Action of Ethylenic Chlorhydrine upon the Pyridic Bases, and on Quinoline. —M. Ad. Wurtz.—In this paper the author examines the action of ethylenic chlorhydrine upon aldehydine and a-collidine.

Influence of the Quantity of Gas dissolved in a Liquid upon its Surface-Tension.—S. Wroblewski.—Under pressures of from 1 to 30 atmospheres there exists a remarkable relation between the laws of solubility of carbonic acid in water and the surface-tension of the liquid. This relation may be expressed in the following manner:—1. The product of the surface-tension, α , by the pressure, P , to which the surface-tension is exposed, is proportional to the coefficient of saturation, S , which corresponds to that pressure,—that is to say, $\alpha P = AS$, A being a coefficient which depends on the temperature and increases with it. According to the first law of solubility, the temperature remaining constant, $\frac{S}{P}$ decreases in proportion as the pressure increases. Experiment shows that the decrease of α is proportional to the decrease of S .

2. The pressure remaining constant, and equal to n atmospheres (when n is greater than 1), it results from the laws of solubility that the quotient—

$$\left(\frac{S}{P}\right)P = n$$

$$\left(\frac{S}{P}\right)P = 1$$

diminishes with the decrease of the temperature. Experiment shows that in this case the ratio of the tensions corresponding to these pressures—

$$\frac{\alpha P = n}{\alpha P = 1}$$

diminishes also.

Numerical Relations between Thermic Data.—D. Tommasi.—The author announces the following law:—When a metal is substituted for another in a saline solution the number of calories liberated is for each metal always the same, whatever may be the nature of the acid which forms part of the salt, or of the halogen combined with the metal.

Researches on the Telephone.—A. d'Arsonval.—This memoir requires the accompanying illustration.

Equivalent of the Phosphorus Iodides.—L. Troost.—The equivalents of the phosphorus iodides, corresponding to 4 vols., are PI_3 and P_2I_4 .

The Formation Heats of the Principal Palladium Compounds.—M. Joannis.—The author finds that hydrocyanic acid not merely decomposes palladium chloride

and bromide (dissolved in the corresponding potassium salts), but even the precipitated palladious iodide. This is a new verification of thermic theories. *A fortiori*, potassium cyanide ought to precipitate the palladious salts, by reason of its feeble heat of neutralisation.

Pyridic Bases derived from Brucine.—M. Oechsner de Coninck.—On distilling brucine and cinchonine with caustic potash there are formed simultaneously two series of isomeric pyridic bases.

Researches on Quinoleine and Lucidine.—M. Amé Pictet.—The author has studied the action of mono-chlorhydrine, epi-chlorhydrine, mono-chloracetic ether, dichlorhydrine, tribromhydrine, and allyl iodide upon quinoleine, and that of mono-chloracetic acid upon β -lutidine.

Journal de Pharmacie et de Chimie.
August, 1882.

Experimental Study on the Action of Potassium Permanganate upon Venoms, Virus, and Zymotic Diseases.—M. Vulpian.—A reply to M. de Quatrefages and M. de Lacerda. The author shows that potassium permanganate, when injected into the circulatory system, is a formidable poison, if introduced in doses sufficient to have any effect upon a poison which is already diffused in the blood. The bite of *Bothrops jacarandi* does not by any means prove invariably fatal in Brazil.

Preparation of Hypophosphoric Acid.—M. Isidore Corne.—The author half fills a large flask with a solution of copper nitrate, adds phosphorus, and heats in the water-bath. More phosphorus is then added, until the liquid is entirely decolourised. The product of the reaction—a mixture of phosphoric, phosphorous, and hypophosphoric acids—is filtered, and half saturated with sodium carbonate. Impure sodium hypophosphite crystallises out, and is purified by repeated crystallisation.

Justus Liebig's Annalen der Chemie,
Band 213, Heft 2.

Contributions to the Knowledge of Acet-acetic Ester.—Dr. C. Duisberg.—The author concludes that Lippmann's dibrom-aceton-carbonic ethyl and Conrad's dibrom-acet-ester dibromide are non-existent; that in acet-acetic ester five atoms of hydrogen may be readily and successively replaced by bromine, forming five different substitution-products. The substitution of the remaining atoms of hydrogen is difficult, and probably is only practicable at higher temperatures. The view of Frankland and Duppa on the constitution of acet-acetic ester is criticised, and various considerations are urged against it.

On Ultramarine.—G. Guckelberger.—In this extensive memoir it is decided that ultramarine blue is a true, definite chemical compound. For its formation a temperature is required equal to the melting-point of zinc, which towards the end of the process should be somewhat raised. The author refers to the analogies existing between the compounds of silicon and those of carbon, and quotes the opinions of Wöhler, Rammelsberger, &c., to this effect.

Bulletin de la Société Chimique de Paris.
June 20, 1882.

On Combustions effected by means of Nitrogen Binoxide.—M. Berthelot.

Observations on the Decomposition of Metallic Formiates in presence of Water.—M. Berthelot.—Two thermo-chemical papers, already noticed.

Russian Chemical Society.—Session of September 10/22, 1881.—The papers read include:—On the

product of the reduction of succinyl chloride, and on normal γ -oxybutyric acid, by M. Saytzeff; on diallyl-ethyl-carbinol, by M. Smirensky. Action of sulphur upon alizarine at high temperatures; on the oxidation of anthraquinone in the cold; formation of sulphuretted hydrogen by the action of oleo-naphtha upon sulphur; and on a case of the transformation of tartaric into racemic acid: these four papers are all by M. Lidoff.

M. Lubavine communicated a memoir on the action of ammonium cyanide upon the aldehyds.

M. Menschoutkine gave an account of the influence of the molecular weight of homologous bodies in the so-called incomplete reactions.

M. Mendelejeff communicated some of the results which he has obtained on studying the petroleum of Baku, of sp. gr. 0.881 to 0.886. Among the products extracted from the tar of the petroleum of Baku, vaseline is found in large proportion.

M. Kajander presented to the Society the continuation of his researches on the speed of chemical reactions.

M. Wilm has studied the action of lighting-gas upon palladium, rhodium, and platinum. He concludes that an addition of palladium or of rhodium to platinum must make the latter metal less useful for chemical apparatus.

July 5, 1882.

Researches on Perchloric Acid.—M. Berthelot.

Detonation of Acetylene, Cyanogen, and Endothermic Compounds in General.—M. Berthelot.—Two thermo-chemical papers, already noticed.

On a Case of Isomerism of Dichlorated Camphor.—P. Cazeneuve.—The author describes a compound which differs from the normal dichlorated camphor in its fundamental physical properties.

On a New Monochloric Camphor.—P. Cazeneuve.—Already noticed.

Cosmos Les Mondes.
No. 14, August 5, 1882.

This issue contains no chemical matter which has not been already noticed elsewhere.

MISCELLANEOUS.

Electric Lighting by Incandescence.—After discussing the four systems of incandescent lamps—the Edison, Swan, Lane Fox, and Maxim—the Jury of the recent International Exhibition of Electricity at Paris write as follows in their official report:—"But none of them would have succeeded had it not been for these extreme vacua which Mr. Crookes has taught us to manage. The members of the Jury of Recompenses are anxious here to express to Mr. Crookes their high approval of his beautiful researches, and at the same time their regret that it is not in their power to award him a prize."

The Chemical Laboratory of Wiesbaden.—In the Summer Term, 1882, there were 60 students on the books. Of these, 44 were from Germany, 5 from North America, 3 from England, 2 from Austro-Hungary and from Russia, and 1 from Switzerland, Belgium, Spain, and South America. Besides the Director, Geh. Hofrath Prof. Dr. R. Fresenius, there are engaged as teachers in the establishment, Dr. H. Fresenius, Dr. E. Borgmann, Dr. W. Fresenius, Dr. E. Hintz, and Architekt J. Brahm. The assistants in the instruction laboratory were two in number, in the private laboratory twelve, and in the Versuchsstation two. Besides scientific researches, numerous analyses were undertaken in the laboratory and the Versuchsstation on behalf of manufacture, trade, mining, and agriculture.

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18 OCT 30 1882

CHEMICAL LITERATURE.

AN ADDRESS DELIVERED BEFORE THE AMERICAN
ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,
AT MONTREAL, AUGUST 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

THE literature of chemistry, extending as it does through a period of more than fourteen centuries, varies greatly in character, in province, and in design; it partakes of the peculiar phases exhibited by the science at different epochs and depicts the experiences and thoughts of those who cultivated it in all ages. It may be studied from several points of view: the biographer searches the voluminous records to acquire knowledge of the intellectual activity of individuals; the historian unfolds the progress made by the science in a special field or in its entirety, with philosophical inquiries respecting effects and causes; the bibliographer, scarcely penetrating beyond the title-pages of the dusty tomes, laboriously catalogues them to facilitate the researches of others.

We do not propose to give you a biographical, an historical, or a bibliographical treatise, but rather to review chemical writings as sources of information and as portions of the world's literary productions. We shall concern ourselves less with the questions what were the personal history and life-work of a given author, and more with the queries what are the characteristics of the various classes of works at different epochs, what discoveries do they chronicle, and what was their influence on the contemporaneous science.

The very earliest information concerning chemical arts comes to us from that ancient nation supposed by some to have given its own name to the science itself: not only do the sculptured tombs and temples of Egypt portray with unimpeachable authenticity and wonderful accuracy the technical skill of that venerable people, but these same monuments are even now relinquishing their hold on long-buried treasures in the form of papyri, whose perplexing script no longer conceals their meaning from the erudition of Egyptologists.

Of these miraculously preserved papyri the most valuable to chemistry is that discovered by Prof. George Ebers at Thebes in 1872, and named after its learned discoverer. We have described this elsewhere* and shall not here enter into details. It is the most ancient medical work extant, being assigned to the sixteenth century B.C., and contains a vast amount of information on the medical practice and the pharmaceutical preparations at that remote period. The unknown author wrote less obscurely than many of a much later date, and when the whole papyrus shall have been deciphered it will prove an invaluable contribution to chemical history.

The most ancient manuscript treating exclusively of chemical operations is a Greek papyrus of Egyptian origin preserved in the Library of the University of Leyden. Its authorship is unknown, its date is placed by Reuvens in the third or fourth century A.D. This MS. consists of a collection of prescriptions and receipts for conducting various operations in metallic chemistry, such as the testing of gold and silver; the purification of lead, of tin, and of silver; the hardening of tin and of silver; the alification of copper, &c. It deals little with alchemy, though some of the receipts evidently refer to transmutations, as those

entitled: "the preparation (artificial?) of silver;" "the preparation of gold;" "the purification of tin by silver," &c.

Reference is made to sandarach (realgar), cadmia (zinc ore), chrysocola, cinnabar, natron (soda), mercury, and other chemical substances, but no receipts are given for their preparation. The author quotes from the *Materia Medica* of Dioscorides, who probably preceded him by about two centuries. It is to be regretted that the full text of this ancient manuscript has never been published; the little known of it foreshadows information of great interest.*

The great libraries of Paris, Rome, Venice, Milan, Escorial, Cracow, Gotha, Munich, and Cologne preserve a large number of Greek alchemical manuscripts of unknown authorship and uncertain date. Hoefer, the French historian of chemistry, refers them to the third and fourth centuries,† but other authorities with greater probability place them not earlier than the tenth and eleventh.‡

The most celebrated of these essays are attributed to Zosimus, of whose history nothing is certainly known, and bear these titles: "On Furnaces and Chemical Instruments," "On the Virtue and Composition of Waters," "On the Holy Water," "On the Sacred Art of Making Gold and Silver." In a treatise attributed to Synesius, we find a description of a hydroscope or hydrometer which was re-discovered as long after as the sixteenth century.

In a treatise attributed to Olympiodorus, he cites as authorities Democritus, Anaximander, Zosimus, Pelagius, and Marie, a certain Jewess whom the later alchemists confounded with Miriam, Moses's sister.

In these manuscripts chemistry is called the "sacred Art," and the exceedingly obscure and figurative language in which they are written makes it well nigh impossible to separate fact from fancy; Hoefer has indeed attempted to discover modern chemical conceptions in the allusions to Egyptian myths and the chaotic collections of spagyric arcana.

Of systematic nomenclature there is absolutely no trace; indeed, each author seems to have aimed to write treatises intelligible only to himself, and we greatly doubt his success in even this respect. "Cadmia," we are informed, "is magnesia," and "magnesia is the female antimony of Macedonia;" "nitre is white sulphur which produces brass;" equally clear is the statement that the "apospersmatism of the dragon is the mercury of cinnabar." That lexicons were early in demand is not surprising; in fact some of the most ancient MSS. are "vocabularies of the sacred art," but even with their assistance it is difficult to form satisfactory concepts of contemporary chemical science.

Suidas,§ a Greek lexicographer of the eleventh century, states that Diocletian having conquered the rebellious Egyptians (296 A.D.) destroyed their books on the preparation of silver and gold, lest becoming rich by the practice of that art they might again resist the Romans. Regrets at the wanton acts of this imperial biblioclast are tempered by the reflection that modern scholars are spared the study of such literary absurdities.

The Chinese, that curious people who always claim a hearing when the origin or antiquity of arts and sciences is under consideration, were acquainted at a very remote period with many branches of chemical technology. We do not know of any special chemical literature produced by them, but the researches of Rev. Joseph Edkins|| and of Dr. W. A. P. Martin¶ make it highly probable that

(Works marked (a) are in the private library of the author).

* (1) "Quarterly Journal of Science," London, vol. 49, p. 95, Jan., 1876. See also: (a) "Materia Medica, Therapeutics and Pharmacy of the Ancient Egyptians," by Dr. Charles Rice, "Medical Record," vol. xi, p. 247, April, 1876.

• (a) *Lettres à M. Levrone sur les papyrus bilingues et grecs de l'université de Leyde*, par C. J. C. Reuvens. Leyde, 1870, *Troisième lettre*, p. 65. See also: (a) *Opp's Beiträge zur Geschichte der Chemie*, I., p. 97, 1869.

† (a) Ferdinand Hoefer, *Histoire de la Chimie*, Paris, 1866, vol. I., p. 261.

‡ (a) G. F. Rodwell, "The Birth of Chemistry," p. 72, London, 1874.

§ (a) Hermann Kopp, *Geschichte der Chemie*, II., 150.

|| "Miscellany or Companion to the Shanghai Almanac for 1857."

¶ (a) "The Chinese, their Education, Philosophy and Letters," New York, 1871.

scholars will yet discover contributions of no small importance to the early history of chemistry. Prof. George Gladstone* has endeavoured to show that the Chinese originated the doctrines and pursuits of alchemy and communicated it to the Arabians by whom it was disseminated throughout Europe.

The high state of civilisation and extraordinary intellectual development of the Arabians has left a deep impression on chemical science. Cultivated chiefly by physicians, attention was directed to its pharmaceutical applications, and in spite of the prohibitions of the Koran to the fascinations of alchemy. Of their extant writings, preserved in European libraries, only a portion have been edited; those best known partake of the poetical imagery and hyperbole characteristic of the Oriental mind. This is shown to some extent in the singular titles prefixed to their treatises, e.g., "The Rise of the Moon under the Auspices of Golden Particles," by the alchemist Dschildegî; "A Poem in the Praise of God, of Mahomet, and of Alchemy," by Dul-nun-el-Misri.†

The well-known treatises of Geber,‡ "Of the Investigation of Perfection," "Of the Sum of Perfection," "Of the Invention of Verity," and "Of Furnaces," notwithstanding a bewildering style of composition, which seems to confirm Dr. Johnson's derivation of gibberish, from Geber, display very great familiarity with a large number of chemical substances and operations.

Geber's works are generally assigned to the eighth century, and consist chiefly of compilations from the "Books of the Ancients;" he mentions no author by name. They contain chapters devoted to the seven known metals, to the methods of distillation, calcination, cupellation, and other operations, to the preparation of saline substances, and to chemical philosophy. Geber adopted Aristotle's views of the constitution of matter from four principles, the hot and cold, the wet and the dry, and adds thereto: "Mercury and sulphur are the components of metals," a doctrine which with slight modifications prevailed for more than eight centuries. Geber describes the preparation of nitric acid, of aqua regia, and of mercuric oxide; he mentions the increase in weight of metals when calcined with sulphur, and gives the results of a rude quantitative analysis of crude sulphur. He constantly maintains the doctrine of transmutation of metals and gives a refutation of the ingenious arguments opposed thereto. His remarks on the qualifications of a chemist are most intelligent and are not inopportune in modern times; he urges the necessity of diligence, patience, learning, a temperate disposition, slowness to anger, and a full purse, "for this science agrees not well with a man poor and indigent," together with faith in the God who "withholds or gives to whom He will" the secrets of nature, and who will infallibly punish the foolish meddler with magical mysteries.

To detail fully our obligations to Arabian chemists is no part of our plan. They have left an indelible impression on the very language of the science, in the words alcohol, alembic, alkali, borax, and many others. All honour to the intelligent authors who a thousand years ago defined chemistry as the "Science of Combustion, the Science of Weight, the Science of the Balance!"§

In the middle ages intellectual activity was confined largely to the clergy, who controlled the schools of learning, the libraries, and nearly all sources of knowledge. University chairs were occupied exclusively by clerical professors.||

* (a) "The Birth of Alchemy," in the "Argonaut," Jan., 1876.

† Cf. (a) Ferdinand Wustenfeld, *Geschichte der Arabischen Aerzte*, Göttingen, 1840.

‡ (a) "The Works of Geber, the most famous Arabian Prince and Philosopher, faithfully Englished by R[ichard] R[ussell]." London, 1678.

§ (a) J. W. Draper, "History of the Intellectual Development of Europe," New York, 1862, p. 303.

|| For more than a century after the founding of the University of Heidelberg, the chairs were exclusively filled by the clergy; the first nomination of a layman to a professorship in the Medical faculty in 1482, encountered violent opposition. Cf. Herman Kopp, (a) *L'état des sciences au moyen âge*, in *Revue des Cours scientifiques*, vol. 7, p. 402, May 28, 1870.

literature and science were cast in ecclesiastical moulds. Scientific treatises were the production of monks and emanated from cloisters. Many distinguished philosophers mastered widely separated branches of learning: among these were Alain de Lille (b. 1114), celebrated as a physician, theologian, poet, and historian, who filled the episcopal chair at Auxerre; Roger Bacon (b. 1214), an English cordelier; Raymond Lully (b. 1235), a Franciscan friar; and Albertus Magnus (b. 1193), Bishop of Ratisbon. The latter, amid the monotonous routine of a Dominican monastery, found leisure to distinguish himself in astronomy, medicine, alchemy, and, according to his enemies, in necromancy. At this remote period, accusations of dealing with magic were not unfrequently made against those whose learning and skill in experimental sciences excited envy and superstitious zeal.*

To treat the writings of these eminent ecclesiastics as a part of chemical literature requires perhaps a stretch of the imagination, yet three hundred years ago they were regarded as masterpieces of the science and formed the text-books of students of alchemy. The writings of these ecclesiastical philosophers are as comprehensive as the branches of learning they cultivated, and incredibly voluminous; Albertus Magnus's collected works fill twenty-one folio volumes.† But a small fraction of these treatises are occupied with science and chemistry; and of this fraction there is in many cases a reasonable doubt as to their authenticity. In fact, nothing was more common than the ascription of work by an obscure second-rate writer to some celebrated philosopher of preceding ages, in order to give the work the stamp of authority,—a deception which, previous to the invention of printing, was more readily accomplished.

It became difficult, therefore, to distinguish the apocryphal writings from the genuine. The former, it is true, frequently betray themselves by anachronisms and other blunders, but many ingenious writers avoided such traps by adopting an enigmatical style worthy of the Delphian oracles.

Basil Valentine was the reputed author of works held in the very highest esteem by the alchemists of the Middle Ages, yet the very existence of this individual is seriously questioned. Mystery surrounds Valentine's entire history, and his writings were given to the world in a most dramatic manner; according to tradition they were hidden in the wall of a church at Erfurt, and long after his death a thunderbolt shattered the wall and revealed the precious documents.

Whether Valentine was a real personage or not the works ascribed to him exhibit great familiarity with many chemical substances and operations, though the obscure and incoherent style renders their intelligent perusal very difficult.

Valentine's celebrated "Chariot of Antimony,"‡ extolling the medical virtues of this metal, is perhaps the least obscure of his works; the "Twelve Keys of Philosophy,"§ with its singular plates, one of the most unintelligible; yet beneath the extravagant jargon characteristic of the period, glimpses are obtained of light and intelligence. The latter work presents clearly the theory that all metals are compounded of three principles: fixedness, metalli- city, and volatility, represented respectively by salt, mercury, and sulphur, an hypothesis which long completely controlled chemistry until it gave place to the seductive theory of Phlogiston. It is uncertain whether the works ascribed to Valentine were first written in Latin or in German; his works were collected in the seventeenth century and have been through many editions.|| Several

* Cf. (a) Naudé, *Apologie pour tous les grands hommes qui ont été accusés de Magie*, Paris, 1669. (The first edition was in 1633).

† Albertus Magnus, "Opera Omnia," Lugduni, 1651, 21 vols., fol. [Consulted in Harvard College Library, Cambridge].

‡ (a) Basil Valentine, "Eis Triumphal Chariot of Antimony, with Annotations of Theodore Kierkringius." London, 1678. See also (.)

§ *Chymische Schriften*, p. 23.

|| The sixth edition bears the title, (a) *Fr. Basilii Valentini Chymische Schriften*, in drei Theile, Leipzig, 1760.

of his treatises have been translated into English and into French.*

In the fifteenth century the newly-invented printing press was employed in the production of few works which can be regarded as chemical, and these were chiefly confined to isolated treatises of the ancient philosophers; in the sixteenth century the alchemists began to publish the results of their industry and speculations, and in the succeeding century a prodigious number of alchemical works were issued in Germany, France, and England, creating literature of an extraordinary type.

Some of these treatises, which are numbered by thousands, record valuable experiments made by enthusiasts seeking the philosopher's stone, but the majority contain "a crude mass of incoherent propositions and wild assertions, a mixture of poesy and insanity, in which all logical ideas are lost amidst the stilted phraseology, but through which breathed a blind yet fervent faith."† Great obscurity of style;‡ an enigmatical method of naming chemical substances which found its highest development in the use of arbitrary symbols and the pictorial representations of alchemical processes;§ the intimate association with astrology; the honest or affected intermingling of pious comments and prayers;|| the extravagant claims to antiquity as respects authorship and processes;¶ the attempts to interpret the mythology of Egypt and Greece on an alchemical basis; the endeavour to associate the mysteries of Hermes with the sacred truths of the Christian religion,**—all combine to produce literary monstrosities as fascinating to the student of chemical history as they are profitless to the practical worker in modern science.

(To be continued.)

ASSAYS OF CINCHONA.††

In these assays it must never be forgotten that the point of greatest importance as well as of greatest difficulty is the complete exhaustion of the bark, and knowing when the exhaustion is complete. Next, it must be always borne in mind that different samples of bark differ very much indeed in structure and, therefore, in accessibility to the exhausting menstruum. Some are soft and spongy, and easily exhausted with a small quantity of liquid in a short time. Others, which do not sensibly differ in appearance of either the bark or its powder, are hard and compact, requiring more liquid and longer digestions. Hence, while the process formerly given is very nicely applicable to some barks, and is entirely sufficient for those upon which its details were adjusted, it does not do equally well for other barks, but may be so modified as to apply equally well to all.

This great difference in the facility with which different cinchona barks are exhausted has been too much overlooked, and it may be the principal cause of the disagreement between Drs. Biel and De Vrij, who, working by

the same process, find a different length of time necessary for the digestion,—the former advising a digestion of four hours, while the latter finds one hour sufficient.

The principles upon which our former process is based are all confirmed by further experience. These are that amylic alcohol freely dissolves all the alkaloids of cinchona barks, but does not dissolve the salts of those alkaloids, and that it dissolves much less of the colouring-matter than other solvents; and the outline of the method is to break up the natural salts of the alkaloids in the bark, and fix the colouring-matters by lime in excess. Then to extract the free alkaloids with amylic alcohol, ether being added to facilitate the percolation and filtration. Then to convert the alkaloids into salts, and thus get them out of the amylic alcohol into a watery solution. Then to precipitate them from the watery solution in the presence of chloroform, which dissolves them freely, and finally to evaporate off the chloroform and weigh the residue as anhydrous alkaloids.

Take of the powdered cinchona 5 grms. = 77·16 grs.

Lime, well burnt, 1·25 " = 19·29 "

Amylic alcohol,

Stronger ether,

Purified chloroform,

Normal solution of oxalic acid,

Normal solution of sodium, and

Water, of each a sufficient quantity,

or, double all the quantities throughout, as well as size of vessels, &c., if the barks be poor, or if it be desired to divide the errors of manipulation.

Add to the lime contained in a 10 c.m. = 4 inch capsule, 30 c.c. = 1 fluid ounce of hot water, and when the lime is slaked, stir the mixture, add the powdered cinchona, stir very thoroughly and digest in a warm place for a few hours, or over night. Then dry the mixture at a low temperature on a water-bath, rub it to powder in the capsule and transfer it to a flask of 100 c.c. = 3·3 fluid ounces capacity, and add to it 25 c.c. = 1 fluid ounce of amylic alcohol. Cork the flask and digest in a water-bath at a boiling temperature and with frequent vigorous shaking for four hours. Then cool and add 60 c.c. = 2 fluid ounces of stronger ether, sp. gr. 0·728, and again shake vigorously and frequently during an hour or more. Filter off the liquid through a double filter of 10 c.m. = 4 inches diameter into a flask of 150 c.c. = 5 fluid ounces capacity, and transfer the residue to the filter. Rinse out the flask on to the filter with a mixture of 10 volumes of amylic alcohol and 40 of stronger ether, and then percolate the residue on the filter with 15 c.c. = 1 fluid ounce of the same mixture added drop by drop from a pipette to the edges of the filter and surface of the residue. Return the residue to the flask from whence it came, add 30 c.c. = 1 fluid ounce of the amylic alcohol and ether mixture, shake vigorously for five minutes or more, and return the whole to the filter. Again percolate the residue with 15 c.c. of the menstruum applied drop by drop from a pipette as before. Then put the filter and residue aside that it may be afterward tested in regard to the degree of exhaustion.

Boil off the ether from the filtrate in the flask by means of a water-bath, taking great care to avoid igniting the ether vapour, and also to avoid explosive boiling by having a long wire in the flask. When boiled down as far as practicable in the flask transfer the remainder to a tared capsule of 10 c.m. = 4 inches diameter, and continue the evaporation on a water-bath until the contents are reduced to about 6 grms. = 92 grs. Transfer this to a flask of 100 c.c. = 3·3 fluid ounces capacity, rinsing the capsule into the flask with not more than 4 c.c. = 64 minims of amylic alcohol. Then add 6 c.c. = 96 minims of water and 4 c.c. = 64 minims of normal solution of oxalic acid, and shake vigorously and frequently during half an hour. Pour the mixture while intimately mixed on to a well-wetted double filter of 12 c.m. = 4½ inches diameter, and filter off the watery solution from the amylic alcohol into

* Cf. (a) *Bibliothèque des Philosophes Chimiques*, Paris, 1741, vol. 3.

† (a) Paul Lacroix, "Science and Literature in the Middle Ages," New York, 1878, p. 187.

‡ Cf. "Basil Valentine's Chariot of Antimony," p. 49.

§ Cf. (a) *Pretiosa Margarita Novella*, Veneti, 1546. [Apud Aldi filios].

¶ Cf. Geber, *op. cit.*, p. 23. "Glauber's Works," vol. 1, p. 277. "Basil Valentine's Works" (*passim*) and the following: "Take seven ounces of this prepared Venus [copper] and put it into a melting pot, when you have finished this work give God thanks and remember the poor;" Raymond Lully, *Philos. Exp.* Chap. II., *ad finem*; in (a) Turner's edition, London, 1657.

¶ Cf. Olaus Borrichius, *De ortu et progressu chemia*, in (a) *Magnetus's Bibl. Chem. Curiosa*, vol. 1, p. 1.

** Cf. Sir George Ripley, Jacob Behmen, and especially Dionisius Andreas Freher's "Analogy in [Barrett's] (a) *Lives of Alchemical Philosophers*," London, 1815, p. 121.

†† From an "Ephemeris of Materia Medica, Pharmacy, Therapeutics, and Collateral Information," by Edward R. Squibb, M.D., Edward H. Squibb, S.D., M.D., and Charles F. Squibb, A.B. Brooklyn, N.Y., July, 1882.

a tared capsule of 10 c.m.=4 inches diameter. Wash the filter and contents with 5 c.c.=80 minims of water applied drop by drop from a pipette to the edges of the filter and surface of the amylic alcohol. Then pour the amylic alcohol back into the flask over the edge of the filter and funnel, rinsing the last portion in with a few drops of water. Add 10 c.c.=160 minims of water and 1 c.c.=16 minims of normal solution of oxalic acid; again shake vigorously for a minute or two, and return the whole to the wetted filter and filter off the watery portion into the capsule with the first portion. Return the amylic alcohol again to the flask, and repeat the washing with the same quantities of water and normal oxalic acid solution. When this has drained through, wash the filter and contents with 5 c.c.=80 minims of water applied drop by drop from a pipette. Evaporate the total filtrate in the capsule on a water-bath at a low temperature until it is reduced to about 15 grms.=241 grs., and transfer this to a flask of 100 c.c.=3.3 fluid ounces capacity, rinsing the capsule into the flask with 5 c.c.=80 minims of water. Add 20 c.c.=0.66 fluid ounce of purified chloroform, and then 6.1 c.c.=98 minims of normal solution of sodium, and shake vigorously for five minutes or more. While still intimately mixed by the shaking, pour the mixture upon a filter of 12 c.m.=4½ inches diameter well wetted with water. When the watery solution has passed through, leaving the chloroform on the filter, wash the filter and chloroform with 5 c.c.=80 minims of water applied drop by drop. Then transfer the chloroform solution by making a pin-hole in the point of the filter, to another filter of 10 c.m.=4 inches diameter, well wetted with chloroform, and placed over a tared flask of 100 c.c.=3.3 fluid ounces capacity. Wash the watery filter through into the chloroform-wet filter with 5 c.c.=80 minims of purified chloroform, and when this has passed through into the flask, wash the chloroform-wet filter also with 5 c.c.=80 minims of chloroform, applied drop by drop to the edges of the filter. When the whole chloroform solution of alkaloids is collected in the flask, boil off the chloroform to dryness in a water-bath, when the alkaloids will be left in warty groups of radiating crystals adhering over the bottom and sides of the flask. Place the flask on its side in a drying stove, and dry at 100° C.=212° F. to a constant weight. The weight of the contents multiplied by 20 gives the percentage of the total alkaloids of the cinchona in an anhydrous condition, to within 0.1 or 0.2 of a per cent if the process has been well managed.

The object of stirring the powdered bark into the slaked lime and water while hot is to swell and permeate the particles as rapidly as possible, introducing the lime solution into the innermost parts of the particles, and this process goes on during the digestion and drying of the mixture. Beside setting the alkaloids free from their natural combinations in the bark, the excess of lime so combines with and fixes the colouring-matters, that even with the red cinchonas the subsequent steps of the process are not confused or obstructed by colouring-matter.

Various other precipitants were tried with this and other menstrua, but none answered so well as lime. The menstruum of ether and alcohol with ammonia, recommended by Biel and adopted by Prolius and De Vrij, were tried, but did not do so well, as lime had to be subsequently used, while the creeping during evaporation was more difficult to avoid.

The digestion and shaking with amylic alcohol doubtless dissolves all the alkaloids present, and dissolves very little beside, but a portion of the solution remains absorbed by the spongy structure of the particles. Such portions can be percolated out on a filter with amylic alcohol and without ether, but the filtration is very tedious and troublesome, requiring more than a day. But by diluting the amylic alcohol with about three times its volume of stronger ether it is rendered very manageable, and the filtration and washings are accomplished in about an hour, leaving the residue practically exhausted. If this solu-

tion be evaporated either spontaneously or by a water-bath it creeps over the edges of the capsule badly, and no good result can be reached. But if it be boiled down in a flask in a water-bath as directed, there is no difficulty, for after the ether is driven off the remainder has no tendency to creep over.

In this part of the process great care must be taken that the ether vapour does not take fire. When evaporated to 6 grms. as ascertained by trying on a scale from time to time, the ether is all gone and a solution of the alkaloids in amylic alcohol remains. One prominent object of the next step of the process, namely, the washing out of the alkaloids from the amylic alcohol as oxalates, is to free them from waxy and fatty matters always extracted from the bark by all solvents which effect a complete exhaustion. In washing out the alkaloids these waxy and fatty matters are left in solution in the amylic alcohol, and with it are thrown away.

If this amylic alcohol be evaporated on a water-bath to a constant weight, the residue will amount to about a half of one per cent of the cinchona taken, and therefore if only a very rough estimate of the total alkaloids be needed, this may be obtained by continuing the evaporation of the amylic alcohol solution to a constant weight and subtracting a half of one per cent from the result.

As the alkaloids are all soluble in amylic alcohol, while their salts are not, a definite quantity of solution of oxalic acid being added, the alkaloids are washed out of the amylic alcohol as acid oxalates. But they are rather difficult to wash out completely, and hence three washings are directed. If close results are not needed, two washings are sufficient. In pouring the amylic alcohol back from the filter into the flask, over the edge of the filter and funnel, a little dexterity is required, and the rim of the funnel must always be somewhat above the filter, in order to be quite successful. The double filter well wetted with water, and kept well wetted, retains the amylic alcohol very well, while the watery solution drains off to the last drop. But should there be any minute holes in the paper, or should the paper not be kept well wetted, a very little of the amylic alcohol may get through; but if so, it does not matter, for it will go off with the vapour in the subsequent evaporation, or adhere to the capsule in an insoluble condition. The solution of the oxalates is too dilute for precipitation, and as it is not acid enough to injure the alkaloids by heat, it is evaporated to 15 grms. As this solution has no tendency to creep, the evaporation is best done on a water-bath. In the next step the alkaloids are precipitated in the presence of chloroform, and it makes a very notable difference in the result if commercial or impure chloroform be used, hence purified chloroform is directed. Having used in all 6 c.c. of normal solution of oxalic acid in converting the alkaloids into acid oxalates, it is only necessary now to add 6.1 c.c. of normal solution of sodium in order to be sure that the precipitation is complete to an alkaline reaction, yet without a sufficient excess of sodium to hold the alkaloids from the chloroform; and hence the use of these normal solutions is important as well as very convenient. After a thorough shaking, the now free alkaloids are all dissolved in the chloroform, and it is only necessary to separate this completely in order to get them all. Here, again, a wet filter becomes a most complete and convenient mode of separation. The watery solution of oxalate of sodium goes through to the last drop, but not a particle of chloroform passes if the paper be good, and here a double filter is not needed; neither is it necessary to wash the filter very much. In the chloroform separation of the alkaloids a film of impurities, soluble in neither liquid, is apt to be present between the two liquids. This is often hardly a weighable quantity, and when small may be neglected and the chloroform solution be at once transferred to the tared flask for evaporation. But in close estimates it is easily separated in the way prescribed, by filtration of the chloroform solution through a chloroform-wetted filter into the flask. This chloroform-wetted filter not only ex-

cludes these impurities, but also any water that may drain out of the water-wetted filter. A pin-hole made in the point of the water-wetted filter is a very good way of transferring from one filter to the other.

The boiling down of the chloroform solution and drying the alkaloids to a constant weight and weighing them in a flask rather than in a capsule, is directed in order to have them in a condition convenient for estimating the ether-soluble alkaloids and quinia.

The above process gives a fairly good and trustworthy account of the total alkaloids in all the cinchona barks to which it has yet been applied, and is more conveniently and easily managed than any hitherto met with which is adapted to the moderate degree of skill possessed by this writer and by well-trained pharmacists generally. There may be, and doubtless are, other processes better adapted to the expert skill of the highly-trained chemist.

Estimation of Quinia.

After much labour, extended over many years, and the trial of all the principal processes which have been published, the writer is obliged to acknowledge that he has found no process for the accurate separation of the cinchona alkaloids which was within the scope of his ability to apply with success. The more complicated and delicate processes of the higher chemists seem only successful in their hands, or at least none of them have thus far come into any general use, and under these circumstances it seems only practicable, in a general way, to reach near approximations by some method which is simple and easy of application.

This much only is claimed for the following process:—

It is common to have the cinchona alkaloids divided into ether-soluble alkaloids, and those not soluble in ether. But this is a very inaccurate sub-division, for all are quite soluble in ether, whether the ether be absolute or 94 per cent, and the application of ether to any mixture will easily dissolve the whole. Thus either the powdered bark itself, or after having been mixed with milk of lime and dried, can easily be exhausted of alkaloids by ether alone. All that can be said is that quinia, quinidia, and cinchonidia are more soluble in ether than the other alkaloids, and that quinia is most soluble of all, and is very soluble,—so soluble that it dissolves in large quantity in ether that has been already saturated with other less soluble alkaloids. And further, that in the presence of any ordinary proportion of any or all the other cinchona alkaloids all the quinia of a mixture will be dissolved by ether if enough of this solvent be present to fully dissolve the quinia if that alkaloid was alone. It is, however, still useful to distinguish the more valuable cinchona alkaloids, namely, quinia, quinidia, and cinchonidia, as the ether-soluble alkaloids, because they can be roughly but still usefully separated by ether in such a way as to better define the values of various barks as they come into the markets for use, and the following process has been contrived to give a fairly good account of the so-called ether-soluble alkaloids as a group, if all are present, and a somewhat less definite account of the quinia as well.

Into the flask containing the total alkaloids, after these have been weighed, put first 5 grms. = 78 grs. of glass, which has been ground up in a mortar to a mixture of coarse and fine powder, and then 5 c.c. = 80 minims of stronger ether. Cork the flask and shake it vigorously until by means of the glass all the alkaloids have been detached from the flask and ground up in the presence of the ether into fine particles. In this way the definite quantity of ether, which is large enough to dissolve all the quinia that could possibly be present, becomes entirely saturated with alkaloids in the proportion of their solubility, and the solution will necessarily embrace all the very soluble ones as the quinia.

Next, mark two test-tubes at the capacity of 10 c.c. = 160 minims each, and place a funnel and filter of 7 c.m. = 2.8 inches diameter over one of them. Wet the filter well

with ether, and then pour on to it the mixture of alkaloids, ether, and glass, from the flask. Rinse the flask out two or three times on to the filter with fresh ether, and then wash the filter, and percolate the glass with fresh ether, applied drop by drop from a pipette, until the liquid in the test-tube reaches the 10 c.c. = 160 minims mark. Then change the funnel to the other test-tube, and continue the washing and percolation with ether until the mark on the second test-tube is reached by the filtrate. Pour the contents of the two test-tubes into two small tared capsules, evaporate to a constant weight, and weigh them. The first capsule will contain what may be called the ether-soluble alkaloids. Subtract from the weight of these the weight of the residue in the second capsule, and the remainder will be the approximate weight of the quinia extracted from the 5 grms. of bark. These weights multiplied by 20 will give the percentage of ether-soluble alkaloids and of quinia.

The explanation upon which these conclusions are based is as follows:—

The quantity of ether used is abundant to dissolve all the quinia and most of the quinidia and cinchonidia, and presumably does so, and dissolves beside all that it is capable of holding of the less soluble alkaloids. This saturated solution is filtered off, displaced, and washed out. Then an equal volume of the solvent ether is applied to the residue containing the less soluble alkaloids, and is presumably nearly saturated by these, but contains no quinia and but little quinidia perhaps, though it contains as much of all the other alkaloids as did the first portion. If the two equal volumes of solvent, then, contain nearly equal quantities of the less soluble alkaloids, while the first contains nearly all of the more soluble ones, then it only needs that the weight of the second residue be subtracted from the weight of the first to leave only the weight of the more soluble alkaloids, such as quinia and quinidia, if the latter should be present.

In two good critical assays, one of red and the other of yellow cinchona, made for the purposes of this paper at this time, the red cinchona (*succirubra* of Ceylon) gave 0.335 grm. of total alkaloids, which is $(0.335 \times 20) = 6.7$ per cent. These total alkaloids then gave 0.210 grm. of ether-soluble alkaloids, which is equal to $(0.210 \times 20) = 4.2$ per cent, and this corrected by subtracting the 0.015 grm. of less soluble alkaloids or $(0.015 \times 20) = 0.3$ per cent, gives $(4.2 - 0.3) = 3.9$ per cent of quinia. Then, as the ordinary sulphate of quinia contains about 73.5 per cent of quinia, this 3.9 per cent of quinia would be equal to $(\text{as } 73.5 : 100 :: 3.9 :) 5.3$ per cent of sulphate.

The yellow bark assayed at the same time (*Cinchona officinalis* from the Ootacamund) gave of total alkaloids 7.3 per cent. Ether-soluble alkaloids 3.48 per cent. Quinia 2.76 per cent. Equal to sulphate of quinia 3.75 per cent.

In connection with these two assays it is worthy of remark that here, as is very rarely the case in the experience of this writer, the red cinchona yields the smaller percentage of total alkaloids with the larger percentage of quinia. Usually the proportions are just the reverse of this between the red and yellow barks.

A Modification of Pettenkofer's Reaction for Bile Acids.—Pettenkofer's test for the bile acids is generally applied by putting in a test-tube a little of the liquid under examination, adding concentrated sulphuric acid and a fragment of sugar, and heating cautiously to 70° C. If a bile acid is present a splendid red colouration appears. This test is open to the difficulty that it is easy to add too much sugar, which becomes carbonised and turns the liquid brown, thus masking the reaction. To avoid this difficulty Drechsel recommends the use of syrupy phosphoric acid instead of sulphuric acid. The carbonisation of the sugar is thus avoided, but, as Becker found on repeating the experiment, no red colouration appears.—*Chemiker Zeitung*.

CALCIC HYPOCHLORITE.

By C. T. KINGZETT, F.I.C., F.C.S.

IN course of some correspondence which appeared in this journal early in 1881, Prof. Lunge stated that he had failed on three several occasions in his attempts to prepare the crystallised calcic hypochlorite which I had isolated (*Journ. Chem. Soc.*, 1875, pp. 405-410) in 1875, but that he would make a further endeavour to obtain the substance by minutely observing my prescriptions, and would publish the results. Shortly afterwards, Mr. Robert Frost, of the Owens College, Manchester, addressed a letter to me, in which he said that at the suggestion of Prof. Roscoe he had undertaken to repeat my experiments, but that so far he also had failed to obtain the crystallised hypochlorite. I was thus led to examine a large number of samples of bleaching-powder, and in no case did I experience any difficulty in obtaining my original compound. Moreover, after the lapse of a few days Mr. Frost kindly wrote me a second letter stating that in the interval he had "succeeded in obtaining a large crop of the crystals with the greatest ease." He had not waited sufficiently long before first writing to me. I now venture to ask Professor Lunge, through your columns, if his final attempt to prepare the crystals was successful.

THE OXIDATION OF TERPENES.

By C. T. KINGZETT, F.I.C., F.C.S.

IN the August number of the *Journal of the Chemical Society* there appears an abstract of a paper which will be found in the *Journal of the Russian Chemical Society* for April last entitled "Formation of Hydrogen Dioxide by the Oxidation of Terpenes," by W. Radulowitsch. This paper contains nothing that was not previously well known, and it amounts in substance to the fact that the author has detected peroxide of hydrogen in the solution, of which during the past few years very large quantities have been prepared for commercial purposes under my personal supervision. Incidentally I may mention that the methods employed by him to quantitatively determine the peroxide of hydrogen are not reliable. Particularly unreliable is the colorimetric method based upon the intensity of the blue colour of the chromium peroxide, because the other constituents influence the reaction.

The author certainly refers to one or more of my contributions to the chemical history of the oxidation of the terpenes, but says that his own results were published in Russian in 1869, thus making a sort of claim of priority. Considering the time and labour I have devoted to this subject, and bearing in mind the entire results of my investigations, and the narrow limit of the observations made by W. Radulowitsch, I must protest against this claim as both ill-judged and ill-timed; but if he really thinks he has been wronged in any way, I would suggest that he should translate his 1869 paper and obtain its insertion in some English journal, to enable English chemists to decide to what extent he is entitled to the credit that has been hitherto accorded to me.

It is perhaps desirable for me to state that this is the first occasion upon which I have met with the name and writings of M. Radulowitsch.

Singular Behaviour of Copper and Lead Salts with Soda-Lye.—If a solution of copper nitrate is mixed with lead acetate (neutral or basic), and if soda-lye is then added till the precipitate first formed is re-dissolved, and the mixture is boiled, the solution instead of depositing black-brown copper oxide becomes clearer and clearer. This phenomenon occurs even in dilute solutions.—*Ber. Oesterr. Ind. Gesell. and Chemiker Zeitung*.

HYDROCARBONS OF FORMULA $(C_5H_8)_n$.

By W. A. TILDEN, D.Sc., F.R.S.

SOME time ago, in a paper read before the Chemical Society of London, I pointed out that the liquid terpenes and citrenes ($C_{10}H_{16}$) cannot be correctly represented as dihydrides of common cymene possessing the constitution usually ascribed to aromatic compounds. The hydrocarbons of the formula C_5H_8 deserve more attention than they have hitherto received, as they appear to supply important evidence in connection with this question.

The most interesting of these compounds is isoprene, a very volatile liquid discovered by Greville Williams among the products of the destructive distillation of india-rubber. It has been further studied by G. Bouchardat with very interesting results.

Isoprene is said to boil at 37° to 38° , though, according to my own observations, its boiling-point is about 3° lower. Its vapour density has been determined, and agrees with the formula C_5H_8 . The bromide of isoprene has not hitherto been described, owing to the difficulty of making it. By careful management, however, I have succeeded in preparing and analysing this substance, and I find that it has the composition of a tetra-bromide, $C_5H_8Br_4$. It is a somewhat oily yellowish liquid, which cannot be distilled without decomposition, and it remains liquid at -18° .

Bouchardat has found that when isoprene is heated to about 280° for some hours, it polymerises into a terpene, which he calls di-isoprene, $C_{10}H_{16}$, together with colophene. This terpene boils at 174° to 176° , and appears to be identical with terpine, the optically inactive hydrocarbon obtained from turpentine. It yields the same dihydrochloride, and by the action of dilute acid may be converted into terpin, $C_{10}H_{22}O_3$, crystallising in the same form as the terpin from common turpentine. I have repeated some of these experiments, and have satisfied myself of the general correctness of the statements in the papers of M. Bouchardat. When subjected to the action of sulphuric acid, isoprene behaves in precisely the same manner as turpentine oil, yielding a terpene and a fluorescent colophene. Isoprene also combines with hydracids like turpentine, and absorbs oxygen rapidly from the air. By the action of dilute solution of chromic acid isoprene is oxidised into carbonic, formic, and acetic acids. When treated with nitric acid it yields a considerable quantity of oxalic acid.

Isoprene presents two characters which distinguish it from the terpenes. One is the peculiar explosive property of the white syrupy substance, which results from its oxidation by air. The other peculiarity—its conversion into true india-rubber or caoutchouc when brought into contact with certain chemical agents, for example, strong aqueous hydrochloric acid as noticed by Bouchardat, or nitrosyl-chloride as observed by myself. It is this character of isoprene which gives it a somewhat practical interest, for if it were possible to obtain this hydrocarbon from some other and more accessible source, the synthetic production of india-rubber could be accomplished.

Since isoprene is converted into a true turpentine by heat, I thought it just possible that by the same agency turpentine might be partly depolymerised into isoprene. When turpentine is passed through a red-hot iron tube and the product fractionally distilled, a small quantity of a liquid is actually obtained, having the same composition and some of the properties of isoprene. It boils at about 37° , and its vapour density by Hofmann's method was found to be 35. The formula C_5H_8 requires 34. By the action of concentrated hydrochloric acid it yields a tough substance closely resembling caoutchouc. The small quantity at present in my possession does not enable me to pronounce positively that this liquid is isoprene, but it seems very probable. A litre of turpentine gave about

* Read before the British Association, Southampton Meeting Section B, 1882.

20 c.c. of the fraction from 37° to 40°, or thereabouts. I am engaged in the preparation of a larger quantity, and in the investigation of the somewhat complex series of hydrocarbons which are formed at the same time. This investigation has already been undertaken by Schultz (*Berichte Deut. Chem. Ges.*, x., 114), who found benzene, toluene, metaxylene, naphthalene, anthracene, methyl-anthracene, and phenanthrene, but nothing of lower boiling-point than benzene.

The hydrocarbon, valerylene, prepared by Reboul from amylene dibromide, and the piperylene obtained by Hofmann (*Berichte*, xiv., 664) in the distillation of trimethyl-piperyl-ammonium hydroxide, are both isomeric with isoprene. So far as at present is known, piperylene differs from valerylene in forming a crystalline tetra-bromide. Isoprene is, I find, unaffected by digestion with mercuric bromide and water, reagents which, according to Kutscheroff (*Berichte*, xiv., 1540b), convert valerylene into a ketone, $C_5H_{10}O$.

These are not the only compounds of formula C_5H_8 . Theoretically there should be eight of them, assuming that the formulæ are all open chains. They are as follows:—

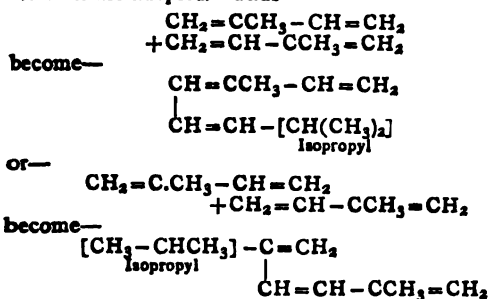
Propyl-acetylene, $(C_3H_7)C \equiv CH$
Isopropyl-acetylene, $(CH_3)_2CHC \equiv CH$
Methyl-ethyl-acetylene, $CH_3C \equiv CC_2H_5$

Ethyl-allene, $C_2H_5HC = C = CH_2$
 α -dimethyl-allene, $CH_3HC = C = CHCH_3$
 β -dimethyl-allene, $(CH_3)_2C = C = CH_2$

α -methyl-crotonylene, $CH_3HC = CH - CH = CH_2$
 β -methyl-crotonylene, $CH_3 = CCH_3 - CH = CH_2$

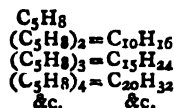
The first three of these compounds seem to have been prepared and identified. They are sharply distinguished from valerylene and isoprene by giving metallic derivatives with copper and silver solutions. From the ready conversion of valerylene into the ketone it probably has the constitution of one of the dimethyl-allenes. Isoprene does not undergo this change, and I incline to the belief that it is β -methyl-crotonylene.

On looking at these formulæ it is difficult to explain by any reasonable hypothesis how either of these compounds could be readily polymerised so as to yield a methyl propyl derivative of benzene such as the terpenes, according to the ordinary hypothesis, are supposed to be. But the condensation of two molecules of β -methyl-crotonylene into one of terpene is not difficult to imagine if my formulæ are adopted. Thus—



These are the formulæ I gave in the paper referred to for two of the three classes of terpenes.

From what I have seen of isoprene I am disposed to look upon it as the first term of a series somewhat analogous to the olefines.



The terpenes therefore must be regarded as peculiar

hydrocarbons, of which there are no true homologues. Certainly, at present, none are known.

The colophene from turpentine appears to be a saturated hydrocarbon of this form, for it does not unite with hydrochloric acid or bromine, though it is gradually attacked by the latter reagent with evolution of hydrobromic acid.

The absorption spectrum of isoprene appears to be peculiar. At the ultra-red end it is pronounced by Capt. Abney to possess the characteristics of an aromatic body, though inasmuch as it contains only C_5 , it is manifestly impossible to regard it as a derivative of benzene. At the other end of the spectrum Prof. Hartley says it has none of the characteristics of the benzene nucleus, but a striking resemblance to Australene, that is to the hydrocarbon of which common turpentine mainly consists.

PROCESS OF MM. BLAS AND MIEST FOR THE ECONOMIC EXTRACTION OF THE PRECIOUS METALS FROM ALL KINDS OF ORES BY ELECTROLYSIS.

THE authors have discovered that if in electrolysis we replace the metal of the anode by compressed sulphur-ores these may themselves serve as an anode. Further, if we place such anodes in a bath of a suitable electrolytic salt having the same metallic base as the metal of the ore, and if we let the electric current act in such a bath, the effect is that all the sulphur of the ore is precipitated upon the anode and falls to the bottom of the bath. At the same time there is formed at the cathode a precipitate or continuous deposit of metal liberated from the salt of which the electrolytic bath consists. The acid of the bath being set free appropriates an equivalent proportion of the metal contained in the ore placed at the anode. In this manner the neutral electrolytic bath is re-constituted without ceasing and serves indefinitely.

Electrolysis of Various Sulphuretted Ores.—For simple sulphides, without gangue, containing only sulphur and a single metal, is exceedingly easy and complete. If we have an electrolytic bath containing a soluble salt of the same base, e.g., a bath of lead nitrate, in case of the treatment of pure galena, this ore is placed at the anode, when under the action of the electric current the sulphur is deposited at the anode and the lead at the cathode. If the ore contains in addition to the metal a siliceous gangue, the silica is deposited at the anode at the same time with the sulphur. But these two substances though mixed together remain distinct. They fall in part to the bottom of the bath, and it is advisable to remove the rest from the anodes by an automatic brushing.

If there are antimony and arsenic in the ore, which are also precipitated at the anode, but chiefly in the state of insoluble oxides, mixed, but not combined together, nothing is easier than to separate them again by electrolysis.

In case of ores containing exceptionally much arsenic, a part of this during precipitation at the anode combines with sulphur, producing arsenic bisulphide or realgar and the yellow sulphide or orpiment.

These products are extracted and purified at first by sulphuret of carbon and afterwards by separate electrolysis in a bath with a feeble electric current, when they yield pure sulphur at the anode and oxides of arsenic and antimony at the cathode.

If we operate electrolytically on sulphides containing several metals, those of the precious metals contained in the sulphur ores, being the most easily precipitated, are thrown down first in the metallic state at the cathode, under the action of a moderate current, and consequently the electrolytic bath is regenerated without ceasing. There is merely one further operation, that of separating afterwards those of the metals which have been thrown down together

at the cathode. But this final separation requires very little electric force, because this mass of metals, already previously reduced to the metallic state and purified, when they are placed together in another electrolytic bath and are dissolved there under the action of the electric current, regenerate the thermic force or thermic work necessary for the ulterior precipitation of each metal separately, saving the slight unimportant and inevitable losses of thermic or electric action.

We extract first the sulphur of carbon disulphide used, with or without pressure. Carbon disulphide dissolves and removes promptly that part of the mixed sulphur which is combined neither with silica nor iron.

On re-distilling the decanted carbon disulphide loaded with dissolved sulphur, the latter is deposited in a state of purity.

If the electrolysed ore is a multiple sulphide, containing especially much iron, we obtain then at the first operation sulphur and iron oxide. If in place of then separating these two bodies by one of the methods described above, we electrolyse them feebly a second time in a bath composed, e.g., of dilute sulphuric acid, we obtain then pure sulphur at the anode, and iron as a basic sulphate at the cathode. But sulphate of iron is in regular demand and of great use in industry. We may otherwise electrolyse it again or use it as an electrolytic salt for the extraction of iron.

In separating the mixture of sulphur and iron oxide there is no outlay of work or of thermic power. On the contrary, in this operation there is production of heat, and consequently of work.

Practically, 1½ horse-power is required to produce electrolytically in one hour one kilogramme of copper set free from a sulphuretted copper ore, a wonderful result in point of economy.

Electrolysis of Complex Ores.—The same process is equally applicable to the extraction of the metals contained in the multiple sulphurets. Such sulphurets are in reality merely combinations of single sulphides combined or mixed together; consequently the decomposition of such a multiple ore in the electrolytic bath, instead of yielding merely a single metal to the acid which is set free, precipitates the precious metals which the ore contains.

Thus, if we place at the anode in an electrolytic trough an ore composed of a multiple sulphuret and make use of a solution of lead nitrate as the electrolytic liquid and let the current act moderately, it will happen that whilst the lead of the electrolytic salt is precipitated at the cathode the metals of the ore placed at the anode will enter into solution simultaneously just in proportion as the acid of the bath is set free, and will ultimately, if easily precipitable, like lead, silver, copper, &c., be thrown down together at the cathode.

Meanwhile the sulphur, the silica, and other insoluble matter in the gangue will be deposited at the anode.

Suppose that we operate upon a multiple argentiferous sulphide of lead, the ore of which contains also iron, copper, and zinc. It may happen that under the action of an electric current sufficiently energetic the iron and zinc dissolve as rapidly as the other metals, but are not as easily precipitated. In this case the electrolytic solution will become gradually saturated with zinc and iron. It is then advisable to regulate the galvanic current so that the lead, silver, gold, and copper may be precipitated alone upon the cathode, keeping the zinc dissolved in the state of zinc nitrate.

As the bath becomes saturated with zinc nitrate, the iron nitrate yields the precedence, and its base falls to the bottom of the bath in the state of ferric oxide.

Finally, when the bath is almost entirely saturated with zinc nitrate, which is kept in a state non-precipitable by regulating the current accordingly, this solution of zinc is syphoned off for separate treatment.

The opportunity is taken to remove the metals, copper, lead, silver, and gold, which have been thrown down upon the cathode in the metallic state. The ferric oxide at the

bottom of the bath is withdrawn separately, and also the sulphur and the silica found at the anode.

The method of ulterior purification of the sulphur is given above.

The metallic zinc contained in the liquid syphoned off may then be precipitated by a more powerful current. If it is desired to collect the zinc in the state of oxide it must be precipitated not electrolytically but by means of chemical reactions.

This separate zinc-bath is treated first with a little zinc oxide, which throws down any iron present in the state of insoluble oxide. Then, if needful, the liquid is placed in a precipitation bath with a zinc plate for anode. A feeble electric current will throw down upon this cathode all the lead, copper, or silver which the bath may retain, leaving merely pure zinc nitrate.—*Les Mondes*.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 7, August 14, 1882.

Appearance of Manganese on the Surface of Rocks.—M. Boussingault.—A long and discursive paper, in which the author quotes largely from Humboldt on the junction between the Amazon and the Orinoco; he refers to the local tradition that the denuded rocks, especially those of granite, are unsafe to encamp or sleep upon. He finds that the black incrustation met with on rocks occasionally submerged in the rivers consists of a dolomite in which manganese carbonate is substituted to a great extent for magnesium carbonate, and is superficially converted into peroxide by exposure to the air. He has detected manganese in the waters of this region.

A New Process for Insulating Electric Wires.—H. Geoffroy.—The author covers the wires with asbestos, and places them then in a tube of lead.

Hydro-dynamic Experiments: an Imitation by means of Liquid of Gaseous Currents of the Magnetic Phenomena obtained with Electric Currents or with Magnets.—C. Decharme.—The author gives instructions for imitating hydro-dynamically the lines of force of an electric current in a plane perpendicular to its direction, or, again, in a plane parallel to its direction; the lines of force of two currents in the same direction, or in opposite directions, and in planes perpendicular to their directions. The large magnetic phenomena produced by magnets, single or combined, are produced in a very similar manner.

Surface-Tension of certain Liquids in Contact with Carbonic Acid.—S. Wroblewski.—The decrease of the surface-tension of the liquid depends solely on the fact that the surface-tension of the liquids with which they are compressed is extremely small.

Certain Arseniates Neutral to Litmus Paper.—MM. Filhol and Senderens.—The authors have obtained a sesquiodic arseniate, but have not found it possible to obtain the corresponding potassium and ammonium salts. They have prepared, however, two double arseniates,—the sodium-ammonium and sodium-potassium salts. The stability of the new phosphates (see *Comptes Rendus*, xciv., p. 449) and arseniates increases with the number of molecules of crystalline water which enters into their composition.

Fermentation of Starch. Presence of a Vibrio in the Grain of Maize during Germination and in the Stem of the Plant.—V. Marciano.—The author finds that the fermentation of chicha, an alcoholic drink pre-

pared from pounded maize, is due to the reproduction in it of a well-characterised organism, which assumes in its development three forms; vibrios, globules with a nucleus like those of yeast and mycelian tubes, from which the vibrios escape at a certain moment.

Cosmos Les Mondes.
No. 15, August 12, 1882.

Dissociation of Copper Sulphate.—D. Tommasi and E. Pegna.—A solution of chemically pure copper sulphate, if boiled, deposits a pale green powder of basic sulphate. The authors have undertaken to determine the quantity of basic sulphate formed with reference to the dilution of the cupric solution. From a 1 per cent solution containing 15 grms. of the sulphate, after boiling for six hours, the quantity of the basic salt obtained was 0.380 gm. The filtrate was boiled again for three hours, and scarcely became turbid. On being again re-heated it grew turbid again, but the turbidity disappeared on stirring. The quantity of the basic sulphate formed increases with the concentration of the solution. The precipitate obtained is also the more basic as the concentration is increased.

No. 16, August 19, 1882.

On Succinine.—Succinic acid, if allowed to act upon glycerin at 200°, forms the succinic ether of glycerin, which Van Bemmelen names succinine. The composition of this body is $C_7H_{10}O_5$. It is insoluble in cold water, but is decomposed on prolonged contact. It is soluble in hot water and hot alcohol, but not in ether, chloroform, benzol, and carbon disulphide.

Revue Universelle des Mines, de la Metallurgie, &c.,
No. 3, May and June, 1882.

This issue contains no chemical matter.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 5.

The Distribution of Heat and Rain during the Growth of the Sugar-Beet.—H. Briem.—A memoir of local interest.

Impoverishment of the Soil by the Removal of Leaves, Twigs, &c., in Woods.—Dr. Hanemann.—This practice deprives the soil of the matter which should be returned to it by the decomposition of the fallen leaves, &c., and makes it unable to retain a sufficient quantity of moisture.

Contributions to the Agronomic Examination of Soils.—Dr. M. Fesca.—The author admits that the chemical and physical properties of an arable soil as determined in the laboratory do not generally allow of a conclusion as to its culture-value. The reason of this must be sought in our imperfect knowledge of the properties and effects of the constituents of the soil. In the present memoir he discusses the value and the means of determining the coefficients of absorption. Absorption depends on chemical changes, which are especially caused by the zeolites (easily soluble silicates) present in the soil. Hence the author views the phenomena of absorption as special phases of the process of weathering. By this term we must understand not merely the physical and chemical destruction of the minerals, but—what is almost more important for the formation of soils—the processes of the transformation of minerals.

Manurial Experiments on the Action of Natural Phosphates.—L. Guillaume.—The author concludes that the application of undissolved phosphates to poor soils is of little value. The application of phosphorite to the sandy soils of Naraucourt in the Ardennes gave increased crops, but the improvement did not cover the outlay.

The number of diseased potatoes was smallest in plots manured with phosphorite alone, larger where a mixture of phosphorite and farm-yard dung was used, and largest with the latter alone.

Manufacture of Saltpetre from the Salts of the Osmose Water derived from the Treatment of Treacle.—Marquis d'Havringcourt.—This process frees sugar-works from a troublesome by-product and leaves a valuable saleable article.

Dung of Deep Stalls.—Dr. A. Emmerling and G. Loges.—Dung which remains for a length of time in deep stalls and is trodden down by the animals and kept moist by their liquid excrements is preserved better, especially as regards its percentage of nitrogen, than that kept in a manure heap. The author, however, concludes that the percentage of effective matter is substantially the same in both.

Manurial Experiments on the Experimental Field of the Agricultural School of Norden.—Dr. Wegner.—According to the results artificial manures can be profitably applied on marsh-lands.

Manurial Results with Osmose Water.—H. Briem.—In experiments with beets the quantity of the crop was greatly increased, but the quality was so deteriorated that the use of this water cannot be recommended. The addition of concentrated osmose water to compost heaps produces a remarkable acceleration of the decomposition of organic matter.

Manurial Experiments with Different Phosphates on the Trial Field of the "Station Agronomique" of Nancy.—L. Grandeau.—In these experiments, precipitated phosphate was found of equal value with superphosphate for equal quantities of phosphoric acid. Bone-meal was worst (possibly from the sparing solubility of its nitrogen, whilst readily soluble nitrates or ammonium salts were added to the other phosphates), whilst phosphorite fell little short of the first-named phosphates. These conclusions apply to light, poor soils, and might require to be modified on land of another quality. Manures containing only potash and phosphoric acid increased the yield by 11.3 per cent as compared with unmanured plots; manures containing in addition nitrogen gave an increase of 40 per cent. It is calculated that the total value of the excreta (human and brute) produced in France, in nitrogen, phosphorus, and potash, is 3½ milliards yearly.

Signification of Asparagine in Animal Nutrition.—Prof. H. Weiske.—Asparagine has a certain value for the nutrition of the herbivora.

Preservation of the Power of Germination in Sprouted Corn.—A. E. Ehrhardt.—Sprouting alone does not necessarily render a second permanent germination impossible.

Aldehyd-like Substances in Chloro-phyllaceous Plant Cells.—Prof. J. Reinke.—From the *Berichte*.

Aldehydic Nature of Living Protoplasm.—O. Loew and T. Bokorny.—A reply to the foregoing paper.

Researches on the Inner Causes of Growth and on their Artificial Modifications.—Dr. K. Kraus.—Experiments on the effect of drying bulbs before planting, on the removal of leaves, on soaking seed before planting, and on heaping up soil over the crown of roots.

Detection of Magenta, Orchil, and Cudbear in Wine.—Dr. B. Haas.—These colours are not suitable for converting white wine into red, but they can be used for giving wines a faint red tint; for darkening pale red wines and in making up a factitious bouquet essence which is added to red wines. The most suitable methods for the detection of magenta are those given by Roméi and Falières-Ritter. If a wine coloured with orchil and one coloured with cudbear are treated according to Roméi's method, the former gives, with basic lead acetate, a blue, and the latter a fine violet precipitate. The filtrate, if shaken up with amylic alcohol, gives it in either c

red colour. A knowledge of this fact is important, or it may be mistaken for magenta. The behaviour of the amylic alcohol, thus coloured red, with hydrochloric acid and ammonia is characteristic. If the red colour is due to magenta it is destroyed by both these reagents, whilst hydrochloric acid does not decolourise the solutions of orchil and cudbear, and ammonia turns their red colour to a purple violet. If the wine is examined according to the Falières-Ritter method in presence of magenta, ether, when shaken up with the wine, previously rendered ammoniacal, remains colourless, whilst if orchil or cudbear is present the ether is coloured red. Wartha has made a convenient modification in the Falières-Ritter method by adding ammonia and ether to the concentrated wine while still warm. If the red colour of the wool is due to orchil or cudbear it is extracted by hydrochloric acid, which is coloured red. Ammonia turns the colour to a purple-violet. König mixed 50 c.c. wine with ammonia in slight excess, and places in the mixture about $\frac{1}{2}$ grm. clean white woollen yarn. The whole is then boiled in a flask until all the alcohol and the excess of ammonia are driven off. The wool taken out of the liquid and purified by washing in water and wringing is moistened in a test-tube with pure potassa lye at 10 per cent. It is carefully heated till the wool is completely dissolved, and the solution when cold is mixed first with half its volume of pure alcohol, upon which is carefully poured the same volume of ether, and the whole is shaken. The stratum of ether decanted off is mixed in a test-tube with a drop of acetic acid. A red colour appears if the slightest trace of magenta is present. The shaking must not be too violent lest an emulsion should be formed. If the wine is coloured with orchil, on prolonged heating, after the addition of ammonia, it is decolourised. If it is then let cool and shaken a little, the red colour returns. If the wool is taken out of the hot liquid after the red colour has disappeared and exposed to the air, it takes a red colour. But if it is quickly taken out of the liquid and at once washed, there remains merely a trace of colour in the wool. If these precautions are observed, magenta can be distinguished from orchil with certainty according to König's method. As the colouring-matter of orchil is not precipitated by baryta and magnesia, but changed to a purple, the baryta method recommended by Pasteur, Balard, and Wurtz, and the magnesia test, are useless. In conclusion the author shows that magenta may in course of time be removed by the precipitates formed in the wine. It is therefore necessary to test not merely the clear liquid, but the sediment, if any.

Preservation of Must by means of Salicylic Acid.—Dr. J. Bersch.—The author finds that 15/200,000 of salicylic acid entirely prevent the formation of mould.

Scherff's Milk.—Dr. B. Martiny.—New milk without any addition is put into glass bottles, stoppered, and then heated by steam for one to two hours to from 100° to 120° under a pressure of from 2 to 4 atmospheres. The milk is thus not merely rendered capable of preservation for an unlimited time, but the caseine is peptonised, so that in contact with the gastric juice it is converted in fine easily divisible and digestible flocks, as in the milk of a not-ruminant animal. The virus of foot-and-mouth disease, tuberculosis, &c., is destroyed.

In what Period of Vegetation is the Chief Activity of Potassium Compounds in Plants?—Prof. V. Th. Magerstein.—A preliminary communication.

Journal für Praktische Chemie.
New Series. Vol. xxv., Nos. 9 and 10.

Bromine Addition-Products of the Crotonic Acids and of Methacrylic Acid.—Dr. Carl Kolbe.—The results of the author's researches are that the dibromobutyric acids obtained from normal crotonic acid and from iso-crotonic acid by the addition of bromine, are

identical, whilst an isomeric compound, dibrom-isobutyric acid, is obtained from methacrylic acid. By decomposition with water or with sodium carbonate we obtain from dibrom-isobutyric acid acetone together with a little propionyl-aldehyd brom-methacrylic acid and brom-oxy-isobutyric acid, whilst the corresponding products of normal dibrom-butyric acid are mono-brom-propylene, oxy-brom-butyric acid, and dioxy-butyric acid. By treatment with soda-lye hydrobromic acid is withdrawn both from normal dibromo- and from dibrom-isobutyric acid, with formation respectively of bromo-crotonic and of brom-methacrylic acids.

Contributions to the Chemistry of the Chrom-ammoniacal Compounds.—S. M. Jørgensen.—In this memoir (which is a continuation from p. 321 of the present volume of this *Journal*) the author describes the normal and basic erythro-chromates, and discusses the theory and formation of the chrom-ammonium salts.

Arsenic Sulphide in Aqueous Solution.—H. Schulze.—The author suggests that in addition to the absolutely insoluble arsen-trisulphide, there exists a second modification of this compound, soluble in water.

MISCELLANEOUS.

New Substitutes for Bone-black.—Dr. A. v. Wachtel and E. A. Schott.—Stranecky's substitute is a mineral consisting of silica, ferric, aluminium, and magnesium oxides, repeatedly saturated with molasses, dried, and ignited. The finished product, which contains 3 per cent of carbon, is less adapted for removing colour than alkali from saccharine juices. Schott's substitute is obtained by re-charring a peat-charcoal along with fat coal.—*Biedermann's Centralblatt.*

Preparation and Quantitative Determination of Tellurium.—Crude tellurium is oxidised in heat with nitric acid, mixed with water, boiled up, and set aside for twenty-four hours. During this time most of the tellurium separates out as tellurous acid. This, together with the sand, is filtered off, dissolved in hydrochloric acid, precipitated with sulphurous acid, the separated tellurium extracted with concentrated hydrochloric acid, filtered, and dried. The filtrate is further treated with sulphurous acid, and the impure tellurium separated out is treated further like crude tellurium. The tellurium thus obtained is pure enough for most purposes, but if a chemically pure tellurium is required it must be distilled in a current of hydrogen.—*Annalen der Chemie und Pharmacie und Chemiker Zeitung.*

ERRATA.—Vol. xlv., p. 216, col. 2, in table headed "Elementary," insert "Chromium, 0.28." In table headed "With the oxygen distributed," for "Iron monoxide, 8.64," read "8.84."

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THE CHEMICAL NEWS

VOL. XLVI. No. 18

23 SEP 82

ADDRESS TO STUDENTS.

TAKING up a subject which we slightly touched upon a year ago, we venture to call the attention of students in chemistry to a consideration which is too much left out of sight at the present day. It has been, perhaps, too much the fashion among those who have urged the claims of chemistry to rank as an important part of higher education to dwell exclusively upon its practical utility, upon its extensive and increasing applications. They have pointed out that, whilst in a majority of cases a knowledge of the classics or of history neither enables a man to get on in the world nor to get the world on, a knowledge of chemistry does both. Perhaps, to look at the claims of chemistry, and of the physical sciences in general, was essential in order to win the suffrages of the utilitarian portion of mankind, whose sole question concerning any and everything is its immediate market-value. But, by going a little too far, the friends of chemical science, just in proportion as they conciliated one class of opponents, played into the hands of another. The supporters of the old educational school contended that the chief value of any study lies not so much in the facts which it communicates, as in the mental discipline which it imparts. They urged that the attention given to the classics was a kind of mental gymnastics, which, even if of no direct utility, rendered the mind fitted for every sphere and every duty of life. Now, in the first part of their contention, viz., that mental training is of more value and importance than the mere amassing of what is commonly called information, these authorities were decidedly right. "Method," as Auguste Comte terms it, ranks higher than "doctrine." But they are utterly wrong in supposing that classical studies were either the only or even the best agency for acquiring mental discipline. This truth—possibly unpalatable to many—will at once appear if we reflect that classical and, for the matter of that, mathematical studies also are utterly powerless to teach the art of observation. They do not habituate students to take in at once, accurately and completely, the attributes of any object placed before them, such as its size, its weight, its colour, texture, hardness, &c., and its relations to and behaviour with other objects. It is true a man may be a born, or a hereditary observer—whose faculties require no special educational training. But such a man is one amongst, perhaps, a hundred thousand. The great majority of men do not and cannot observe either objects or events correctly without they have gone through a systematic training. This training can best be obtained by the careful study of physics, chemistry, or biology, chemistry being, if anything, the most convenient study for the purpose.

Again, how, except by the study of some one of the physical sciences, can a man learn the most important and delicate art of experimentation, that is, of putting definite questions to Nature? It is simply and absolutely impossible.

But we may go further: The dominant part played by classical studies, or, more comprehensively speaking, by literature, in our national system of education, not merely fails to teach the student the two grand arts of observation and experiment; it formally, if we may use the expression, *unteaches* them and crowds them out. This it does by fixing the attention exclusively on words, to the neglect of things. The word-monger sees the world only through the medium of paper,—a very dim and opaque one at the best.

Furthermore, physical science not merely teaches us the arts of observation and experiment; it gives the best training in the art of co-ordinating and explaining the phenomena which we have observed or elicited. It shows us how to frame provisional theories, how to bring them to the test, and how to modify them so as to be a gradually more and more complete approximation to the truth. Now in these processes the mere logician, and even the mere mathematician, unless also trained in the physical or natural disciplines, generally fall into egregious errors. The logician may argue correctly, but he does not and cannot test his premisses. The mathematician lays down formidable arrays of formulæ, but he too often quietly begs the question in such words as "if we only assume," "if we then suppose," "let it be granted," and the like, when in too many cases there is no right to assume, suppose, or grant anything of the kind.

It has been said that almost the whole business of life may be resolved into drawing right conclusions from facts correctly observed. If this be the case, chemistry, as teaching the arts of observing and interpreting phenomena, must be of incalculable educational value, not merely to those who devote their lives to research, not merely to those who find in it a professional or a trade interest, but to the great mass of the public.

We have often permitted ourselves to dream of a type of education, based from the very outset on a systematic culture of the perceptive powers; where the pupil, instead of, as now, learning from books and occasionally referring to things by way of illustration, should learn from things and refer to books by way of recapitulation and extension. In such a system, chemistry would play a most important part. Of course it would require to be taught in a manner somewhat heterodox, beginning, not with abstractions, names, symbols, calculations, and theories, to be taken on faith, but with the concrete phase of the science.

One thing we admit the study of the natural sciences cannot effect—it will not teach the art of expression. But if the world gets wiser, it will set less and less value on this art. It will feel more indebted to the man who tells it some new truth in the simplest language rather than to the orator or the novelist, who clothes the most threadbare or the most deceptive ideas in ornate and seductive language.

Researches on the Physical Properties of the Soil in a Dense and a Loose State.—Prof. E. Wollny.—Density of soil is to be aimed at when it is desired to increase the proportion of water in the soil, and a loose condition should be maintained where the contrary state is found needful. The more densely the particles of the soil are aggregated together, the more such soil will vary in temperature.—*Biedermann's Centralblatt*.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

CANDIDATES for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 8th, 1883. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitor declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the Intermediate Examination in Laws, or at the Preliminary Scientific M.B. Examination, and Intermediate Examination in Medicine, within three academical years from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the Intermediate Examination either in Arts or in Science in the following July.

INTERMEDIATE EXAMINATION IN SCIENCE.

The Intermediate Examination in Science will be held in July, 1883.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The Examination embraces the following subjects:—Pure and Mixed Mathematics, Inorganic Chemistry, Experimental Physics, and General Biology.

Examination for Honours.

Any Candidate who has passed the Intermediate Examination in Science in all its subjects may be examined at the Honours Examination next following the Intermediate

Examination in Science at which he has passed for Honours in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Pure and Mixed Mathematics at the Intermediate Examination in Arts, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the Preliminary Scientific (M.B.) Examination in either of the subjects which are common to it with the Intermediate Examination in Science, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, which will consist of six hours' examination by printed papers and of six hours' practical work, will take place on Thursday and Friday (with Saturday if necessary) in the same week with the Examination for Honours in Mathematics, commencing on each day at 10 a.m.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself in Mathematics, will receive an Exhibition of £40 per annum for the next two years.

B.Sc. EXAMINATION.

The B.Sc. Examination will be held in October.

Candidates for this Examination are required to have passed the Intermediate Examination in Science at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select any three of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

Any Candidate who has passed the B.Sc. Examination, and has not previously passed the B.A. Examination, may be examined at the Honours Examination next following the B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Mental and Moral Science, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

DOCTOR OF SCIENCE.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the Intermediate Examination in Science, in which case he shall be admitted to the examination for the Degree of Doctor of Science at the expiration of one Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc. is examined in some one or more of the various branches of Physical, Biological, Geological and Palæontological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examination test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be examined.

BRANCH IV. OF PHYSICAL SCIENCE.
INORGANIC CHEMISTRY.

Principal Subject—Inorganic Chemistry.

Subsidiary Subjects—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

BRANCH V., ORGANIC CHEMISTRY.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

PRELIMINARY SCIENTIFIC (M.B.) EXAMINATION.

This examination will be held in July, 1883.

No Candidate is admitted to this examination until he has passed the Matriculation Examination,* and notice must be given to the Registrar at least 14 days before the commencement of the examination. The fee for this examination is five pounds.

Candidates for the degree of M.B. are strongly recommended by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who has passed the Preliminary Scientific (M.B.) Examination, may be examined at the Honours Examination next following the Preliminary Scientific Examination at which he has passed, unless he has previously obtained an Exhibition in any one of the subjects at the First B.Sc. Examination, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass at the same time in the Pure Mathematics of the Intermediate Examination in Science, or who have previously passed the Intermediate Examination in Arts, are admissible to the B.Sc. Examination.—One Fee of £5, paid on entering for the Preliminary Scientific Examination also admits a Candidate to the Mathematics of the Intermediate Examination in Science, if taken at the same time.

Examination. In addition they are examined practically in Simple Qualitative Analysis.

EXAMINATION IN SUBJECTS RELATING TO PUBLIC HEALTH.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in this University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

GILCHRIST SCHOLARSHIPS.

1. A Scholarship of the value of Fifty Pounds per annum, and tenable for three years, is annually awarded to the Candidate from the Royal Medical College, Epsom, who at the June Matriculation Examination stands highest among the Candidates approved by the Head Master of that Institution, and who passes either in the Honours List or in the First Division; on condition of his prosecuting his studies during the tenure of his Scholarship with a view to Graduation in one of the Faculties of the University of London.—Particulars may be obtained on application to the Secretary of the Royal Medical College, 37, Soho Square, W.

2. A similar amount is annually offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as aforesaid who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

3. A Scholarship of Fifty Pounds per annum, tenable for three years, is also annually awarded to that Candidate in the Honours Division at the June Matriculation Examination who shall stand highest of the Candidates previously approved by the Principal of University College, Bristol; and who intends to study at that College with a view to graduation in one of the Faculties of the University of London. [N.B.—This Scholarship is open to Women.] Further particulars may be obtained on application to the Principal of University College, Bristol.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, 4, Broad Sanctuary, Westminster, S.W.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the

University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

OXFORD LOCAL EXAMINATIONS.

These Examinations will commence on Monday, June 4, 1883.

Printed forms, on which Candidates are to make application, will be prepared by the 1st of March and may be obtained until Saturday, 7th of April, after which date none will be issued. The Forms for Junior and Senior Candidates are distinct.

For examination in Oxford the Forms may be obtained from G. E. Baker, Esq., Clarendon Building, Oxford.

The same Forms may be obtained from the various Local Secretaries, from whom also all other necessary information may be procured.

The Printed Forms, duly filled up, must be returned to the several Local Secretaries by Saturday, April 14th. No Candidate's name will be received at any place after that day. The words "Local Examinations" should be written on the covers of all letters addressed to the Secretaries.

Fees.—Every Junior Candidate is required to pay a Fee of 20s., every Senior Candidate 30s.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.
Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

Demonstrators.—J. W. Hicks, M.A., W. J. Sell, B.A., and H. J. H. Fenton, B.A.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academic Year:—

MICHAELMAS TERM, 1882.

General Course, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Oct. 12.

Physical Chemistry (Advanced), by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 13.

Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Oct. 14.

Metals, by Mr. Pattison Muir, Caius College, Monday, Wednesday, and Friday, at 10 a.m. Begin Oct. 13.

General Principles of Chemistry, by Mr. Pattison Muir, Caius College, Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Oct. 15.

Spectroscopic Analysis, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 1.30 p.m. Begin Oct. 19.

Practical Chemistry, by the Professor and the Demonstrators of Chemistry. University Laboratory. Also at St. John's, Caius, Sidney, and Downing Colleges. Daily. Begin Oct. 11.

LENT TERM, 1883.

General Course continued, by the Professor of Chemistry, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Jan. 23.

Organic Chemistry, by the Jacksonian Professor, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Jan. 24.

General Course of Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Jan. 23.

Non-metallic Elements, by Mr. Pattison Muir, at Caius College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Jan. 24.

General Principles of Chemistry continued, by Mr. Pattison Muir, Caius College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Jan. 25.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m.

Practical Chemistry, at the University Laboratory, daily. Begin Jan. 15. And at St. John's, Caius, and Sidney Colleges, daily. Begin Jan. 22.

EASTER TERM, 1883.

Elementary Chemistry, by a Demonstrator, on Mondays, Wednesdays, and Fridays, at 3 p.m. Begin April 16.

General Course continued, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 11. Begin April 19.

Non-Metals (continued) and Organic Chemistry (Elementary), by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 18.

General Principles (continued) and Organic Chemistry (Advanced), by Mr. Pattison Muir, Caius College. Tuesdays, Thursdays, and Saturdays, at 10. Begin April 19.

Practical Chemistry, at the University Laboratory, daily. Begin April 12. Also at St. John's College. Begin April 16. Also at Caius College. Begin April 18. Also at Sidney College.

KING'S COLLEGE.

(DEPARTMENT OF ENGINEERING AND APPLIED SCIENCE.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *visâ voce* and by written papers, are held at interval during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. od.; per ann., £8 8s. od.; Practical Chemistry per term, £4 4s. od.; per ann., £10 10s. od.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. od.; Three Months (daily attendance), £10 10s. od.; Six Months (daily attendance), £18 18s. od.; Nine Months (daily attendance), £26 5s. od. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1882-83, are Tuesday, October 3, Tuesday, January 9, and Wednesday, April 11.

METALLURGY.

Professor.—A. K. Huntington, F.I.C., F.C.S., &c.

The Laboratory for instruction in Metallurgy will be open to Students every day from 10 to 4 (except on Saturday, when the College closes at 1); on Friday evenings from 7 to 9.

Lectures will be delivered on Monday and Friday at 4 p.m. in the Michaelmas and Lent Terms; on Thursday at 3 p.m. in the Easter Term; and on Wednesday at p.m.

The following subjects are treated of in these Lectures: The Selection and Economic Preparation of Fuel and of Refractory Materials; the Methods by which Metals are obtained from their ores, and the means by which they are rendered suitable for the various requirements of the Arts.

Particular attention is made to the study of the Nature and Properties of Metals and Alloys available for Constructive Purposes.

In the Metallurgical Laboratory, which is always open during College hours, the relation between the Chemical Composition of Metals and their Mechanical Properties may be studied by the aid of Testing Machinery. The study of the other subjects above referred to, and also of Assaying, is carried on under the direction of the Professor.

Fees.—Lectures only, £3 3s. Practice (including Lectures), for one month, £6 6s.; two, £11 11s.; three, £15 15s.; six, £27 6s.; nine, £37 16s.

The Course of Evening Lectures will relate to Metals and Alloys, with special reference to the Manufacture of Brass and Bronze. **Fees.**—For Lectures only, £1 11s. 6d.; Laboratory only, £2 2s.

EVENING CLASSES.

Classes for Evening Instruction in various subjects are held during the months from October to March, inclusive,

and during the months of April, May, and June. The next Winter Course will begin on Monday, October 9th, and will terminate on Friday, March 16th, 1883, the last fortnight being devoted to examinations. Many of these classes have special reference to the B.A. and Matriculation Examinations of the University of London.

Agriculture.—A Course of Lectures on this subject will be given during the ensuing Winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The Lectures will be given on Thursday Evenings at 6 p.m., beginning October 12th, 1882. Fee, £1 11s. 6d. for the Course, to be paid in advance at the College Office.

UNIVERSITY COLLEGE. FACULTY OF SCIENCE.

Chemistry.—Professor Williamson, Ph.D., F.R.S.

I. GENERAL COURSE.

Lectures daily (except Saturday) from 11 to 12 a.m., up to the last week in March.

Exercises on Tuesdays, Wednesdays, Thursdays, and Fridays, from 9 to 10 a.m. First Meeting, October 4, 1882

Fees for the Course, £7 7s.; Perpetual, £9 9s.; for the Half Course, £4 4s.; for the Organic Course alone, £2 2s. Fee for the Exercise Class, £2 2s.

The instruction in this Class is of two kinds, consisting partly of Experimental Lectures by the Professor, partly of Exercises and personal instruction on the subject of the Lectures by an Assistant.

Attendance on the Exercise Class (conducted by Mr. Temple A. Orme, F.C.S.) enables Students to do their work more effectually and rapidly than they can do by themselves.

A. The first half of the course, to Christmas, includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

B. The second half of the Course, from January to March, includes the following subjects:—

1. Preparation and properties of the chief Metals, including their characteristic reactions and most important salts. Detection of metallic poisons. Quantitative estimation of metals. Principles of classification. Monoatomic, diatomic metals, &c.

2. Organic Chemistry commences in the second week in February, and occupies five Lectures weekly till about the end of March. It includes a study of the characteristics and metamorphoses of the chief organic acids, bases, alcohols, ethers, colouring-matters, &c. Methods of ultimate and proximate analysis. Determination of molecular weights. Theory of types; of compound radicals. Phenomena of fermentation, &c.

Training of Teachers.

Teachers of Chemistry are trained in the theory and practice of their profession. A two years' Course is absolutely requisite for this purpose; but Students will with advantage devote a longer period to it.

II.—ANALYTICAL AND PRACTICAL CHEMISTRY.

A. Laboratory.

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c. Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are open daily from 9 a.m. to 4 p.m., from October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees, for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

A Gold Medal and Certificates of Honour are competed for by students entered for the session.

B.—SUMMER PRACTICAL COURSES. *Chemical Theatre.*

1. *Elementary Course. (Men.)*—About Forty Lessons of one hour each, commencing in the first week of May.; The first six weeks of the Course are occupied by the study of the chief non-metallic elements and their simple compounds. Metallic salts, &c., are subsequently studied.

Fees—including the cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

2. *Senior Course. (Men.)*—This Course consists of Twenty Lessons of two hours each, commencing in the first week in May.

The first half of the Course includes tests for fixed and volatile organic acids, nitrogenised acids, sugars, glycerin, alkaloids, &c.

The second half of the Course includes tests for mineral poisons in organic mixtures; also tests for organic bodies, such as alkaloids, when mixed with other organic substances.

Volumetric methods of the quantitative analysis of sugar and urea, chlorides, phosphates, hardness of water, alkalimetry, are practised.

Analysis of milk and ashes of blood.

Fees—including cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

III.—SUMMER MATRICULATION COURSE. (Men.) TEMPLE A. ORME, F.C.S.

This Course includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Course consists of about Twenty Lessons in Practical Chemistry, and of an equal number of oral lessons. These lessons will begin on April 10, 1883, at 11.

Fee, including cost of materials and apparatus, £4 4s.

IV.—ELEMENTARY CHEMISTRY. *Chemical Theatre. (Women).*

Lectures—Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Winter Session, commencing Wednesday, October 11.

The instruction will consist partly of Lectures, partly of Laboratory Experiments performed by the Students.

Fees for the Course, including use of apparatus and materials, £4 4s.

Chemical Technology.

Professor CHARLES GRAHAM, D.Sc., F.I.C.

Assistant.—C. J. Wilson, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

In the Session 1882-83, it is proposed to treat of the following subjects:—

- (1) The Chemistry of the Alkali trade.
- (2) Soap, Glass, Pottery, Cements.
- (3) Chemistry of Brewing.
- (4) Agricultural Chemistry.

Fees—for each Course, £2 2s.; for the four Courses together, £5 5s.

Laboratory of Chemical Technology.

The instruction in the Laboratory of Chemical Technology will consist of the examination and valuation of raw materials used, and of the final products obtained in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m.,

from the 4th of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES.

Professor.—E. Frankland, Ph.D., D.C.L., F.R.S.

Assistant Professor.—F. R. Japp, M.A., Ph.D.

Demonstrators.—W. R. Hodgkinson, Ph.D., and P. F. Frankland, Ph.D., B.Sc.

Assistants.—G. S. Newth and H. Chapman Jones.

The Normal School of Science at South Kensington is intended, primarily, for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department. The Royal School of Mines is affiliated to the Normal School. Students entering for the Associateship of the School of Mines obtain their general scientific training in the Normal School. Other students are admitted so far as there may be accommodation for them, on the payment of fees fixed at a scale sufficiently high to prevent undue competition with institutions which do not receive State aid. The instruction in the Normal School is arranged in such a manner as to give the Students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science. The Associateship is granted in certain divisions or lines of study. Students who go through any one of the prescribed courses of instruction and pass the necessary Examinations receive a Certificate of Associateship of the Normal School, or of the Royal School of Mines. But students who are not candidates for the Associateship are permitted to take up the course of instruction in one or more special branches of science, and on passing the examination receive a Certificate to that effect. The Associateship of the Normal School of Science is given in one or more of the following divisions:—Mechanics, Physics, Chemistry, Biology, Geology, and Agriculture, and the Associateship of the Royal School of Mines in Metallurgy and Mining.

The course of instruction is the same for all the divisions during the first two years, after which it is specialised in accordance with the Scheme detailed in the Prospectus of the School.

The Session is divided into two Terms. The first Term begins about the 1st of October and ends about the middle of February. The second Term begins in the middle of February and ends about the middle of June.

Examinations are held at the end of each course of instruction and at such other periods as may be found necessary. On the results of these examinations the successful candidates are arranged in two classes, first and second. There are also "Honours" examinations for the subjects of the third and fourth years, the successful candidates being placed in order of merit. A student obtains the Associateship who passes in all the subjects of the first two years and of the special division he selects for his Associateship. A student who goes through the prescribed course of instruction in any subject and passes the final examination in it receives a certificate to that effect.

Students who do not wish to attend the lectures are admitted for short periods to the laboratories, at the discretion of the Professors. The fees for the Chemical, Metallurgical, and Physical laboratories are £5 per month; for the Biological and Geological laboratories £4 per month.

Admission is granted to persons desirous of attending certain courses of the lectures without the laboratory instruction, on payment of the lecture fees.

The fees which are shown in the following table must be paid to the Registrar of the School before the commencement of each course.

	Part I. Lecs.	Part II. Lab.	Part III. Lecs. & Lab.	Part IV. Lecs. & Lab.	
Chemistry	£ 5	£ 10	£ 18	£ 18	
Physics	5	12	16	16	
Biology with Botany .. .	4	8	8	4	8
Geology with Mineralogy ..	4	8	12		
Mechanics	4	6	10	10	
Metallurgy	2	16	18		
Assaying for Mining Students		12			
Mining	4	12			
Agriculture	4	10			
Astronomy	3				

Mathematics £3 per term. Practical Geometry and Mechanical Drawing £3 per term. Freehand Drawing £1 per term.

Thus the fees for the first two years amount to £75, and for the remainder of the course for the Associateship they vary from £30 to £40.

Both the private and the State-aided students are required to furnish themselves with certain instruments and apparatus before the commencement of the courses. These are enumerated in the syllabuses of the several subjects.

Officers of the Army, Navy, and Civil Service, recommended by their respective Departments, are admitted to the Lectures and Laboratories at half the foregoing charges.

Associates of the Normal School of Science and of the Royal School of Mines have the privilege of free admission to the Library and to all the courses of lectures.

Science teachers actually engaged in teaching who have passed in the advanced stage, or in honours, in any subject in the May examination of the Science and Art Department, or in the December examination in Training Colleges, may attend any course of lectures on the payment of £1.

Several valuable Exhibitions, Scholarships, and Prizes are attached to the studentship.

Summer Courses for Teachers.—Short courses of instruction are given annually, about July, in different branches of science for the benefit of teachers of science schools in the country. The courses last three weeks. About 200 teachers are admitted to them, and they receive 2nd class railway fare to and from London, and a bonus towards their incidental expenses of £2 each. (See Science Directory.)

Working Men's Lectures.—Three or four courses of evening lectures for working men are given annually during the winter months by the Professors and Lecturers of the Normal School and the School of Mines. The admission to each course of six lectures, which will be given at South Kensington, Jermyn Street, or Bethnal Green, is 6d. The number of tickets is limited by the size of the lecture theatre.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry and Experimental Physics.—T. S. Humpidge, Ph.D., B.Sc. (Lond.)

The following courses of lectures will be delivered during the Session 1882-3, commencing on Sept. 18th.

1. **Inorganic Chemistry.**—A course of about 80 experimental lectures on the Non-Metals, Metals, and Theoretical Chemistry.

2. **Organic Chemistry.**—A similar course of about 40 lectures.

3. **Experimental Physics.**—A course of about 90 experimental lectures.

These lectures will all be delivered in the forenoon.

The **Chemical Laboratory**, fitted with appliances, will be open daily (Saturdays excepted), from 2 to 6 p.m.

Fee for all subjects extending over the whole Session, £10. Practical Chemistry, 5s. per term extra.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.
Lecturer.—Sydney Young, B.Sc.

DAY LECTURES.

Inorganic Chemistry.

This Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given at 9 o'clock on Mondays, Wednesdays, Fridays, and Saturdays during the First and Second Terms.

The lectures will be illustrated with experiments and diagrams.

Examinations will be held from time to time during the courses.

Fee, £4 4s. for two Terms, £3 3s. for one Term.

Special Laboratory Course.

Special instruction will be given on Tuesdays and Thursdays from 4 to 6. The Course is designed for Students entering for elementary examinations in Chemistry, and others to whom the hour may prove convenient.

Fees, £3 3s. for two Terms; £2 2s. for one Term.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 9 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 9 o'clock.

Special Lectures will also be given.

Fee, £3 3s.

Advanced Course.

This Course will be given on Saturdays at 9 o'clock during the first and second Terms, and will be devoted to a more minute consideration of Chemical Theory, as shown in recent researches.

Fee, £2 2s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures. The Laboratory is under the immediate supervision of the Professor and the Lecturer.

Fees in Guineas—

	Whole Day.			Half Day.	
	6 Days a Week.	3 Days a Week.	2 Days a Week.	6 Days a Week.	3 Days a Week.
Per Session	18	10	7½	12	7
" Two Terms ..	13	7½	5½	8½	
" One Term ..	7	4	3	4½	3
" Month	3	2	1½		

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

EVENING LECTURES.

Inorganic Chemistry.

Lecturer.—Sydney Young, B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the Principles of Chemistry and Chemical Physics and the Chemistry of the Non-Metallic Elements. A few Lectures at the end of the Course will be devoted to the consideration of the Chemistry of Metals. Special attention will be paid throughout to

those products which have a practical application in the Arts and Manufactures.

Fee, 10s. 6d. for Two Terms; 7s. for One Term.

Technical Chemistry.—Special Courses.

Professor.—W. Ramsay, Ph.D.

First Term.—A Course of Lectures will be delivered on Thursday evenings at 8 o'clock, on Fuel, and on the Metallurgy of Iron and Steel.

Second Term.—A Course of Lectures will be delivered on Thursday evenings at 8 o'clock, on Wool, Silk, Cotton, Linen, and Jute. This course is designed to afford information to those engaged in the manufacture and sale of articles made of the above materials. It will imply no previous knowledge of chemistry; but those who purpose to attend it are recommended to enter the Evening Chemistry Classes during the first Term.

Fee, 10s. 6d. for two Terms; 7s. for one Term.

Chemical Scholarship.—Among others, a Chemical Scholarship of £25 is offered for competition.

All particulars may be learned by application to J. N. Langley, LL.D., Registrar and Secretary.

ROYAL AGRICULTURAL COLLEGE,
CIRENCESTER.

CHEMICAL DEPARTMENT.

Professor.—Prof. E. Kinch, F.C.S., F.I.C.

Assistants.—H. H. Robinson, B.A., and Mr. W. James.

Systematic courses of Lectures are given on Inorganic, Organic, and Agricultural Chemistry, illustrated by experiments, and by the collections in the College Museum. They comprise, as preliminary, the laws of Chemical Combination and the general Chemistry of mineral bodies, and of the more frequently occurring bodies of organic origin, with the relationship of their leading groups; and, finally, the Chemistry of the atmosphere, of soils and manures, of vegetation and animal nutrition, and of Agricultural economy.

In the Laboratory practical instruction is given in the construction and use of apparatus and in Chemical manipulation and analysis, both qualitative and quantitative. After studying the simple operations and the properties of the commonly occurring substances, the Students are taught to analyse a series of compounds, and apply the knowledge thus obtained to the analysis of manures, soils, waters, foods and feeding stuffs, and ther substances met with in the ordinary course of Agricultural practice. Chemico-agricultural researches are undertaken by the senior Students under the direction of the Professor and his Assistants.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Assistant Lecturer.—C. H. Bothamley, F.C.S.

The Session begins October 3rd, 1882.

Students of the Leeds School of Medicine are admitted to any of the classes on payment of the class fees, and are not charged with the College entrance fee.

Lecture Courses.

1. General Course on Inorganic and Organic Chemistry—Monday, Tuesday, Thursday, and Friday, at 4 p.m., from October to the end of the second term. Fee for the Course, £4 4s.

2. Lectures on Laboratory Practice and Chemical Calculation—Wednesday, at 10 a.m., during the First and Second Terms. Fee, £1 1s.

3. Lectures on the Chemistry of the Non-Metals—Saturday, at 12, during the First and Second Terms. Fee, 10s. 6d.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session.—Students working six days per week, £17 17s.; four, £13 13s.; three £11 11s.; two, £8 8s.; one, £4 4s.

Class in Practical Chemistry, Saturday mornings, from 9 to 12, during First and Second Terms. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Wednesdays, at 8 p.m., beginning October 11. Fee, 10s. 6d.

A Course of Twenty Lectures by Mr. C. H. Bothamley on the Metals will be given during the first and second Terms, on Mondays, at 8 p.m., beginning Oct. 9. Fee, 10s. 6d.

Dyeing Department.

Instructor.—J. J. Hummel, F.C.S.

Lecture Course, with practical work in the Dye-house, for Students who wish to receive, on leaving the College, a certificate of proficiency in Dyeing; such certificate to be obtained by special examination in the several subjects of the Course, the latter extending over a period of two years.

Scholarships.

For Associates.—The Cavendish Scholarship. Value £50 per annum, tenable for one year.

Advanced Scholarships.—

The Brown Scholarship. Value £35, tenable for two years.

The Akroyd Scholarship. Value £30 per annum, tenable for two years.

Entrance Scholarships.—

The Salt Scholarship. Value £20 per annum, tenable for two years.

The Goodall Exhibition of £10, tenable for one year, will be awarded to the candidate who shall take the second place in the competition for the Salt Scholarship.

The Akroyd Scholarships. One, value £25, and one, value £20, tenable for two years.

The Brown Scholarships. One, value £25, and one, value £20, tenable for two years.

The Clothworkers' Company Scholarships. For Textile Department four Scholarships, and for Dyeing Department two Scholarships, each of the value of £25 per annum, and tenable for one year.

MASON SCIENCE COLLEGE, BIRMINGHAM.

Professor.—W. A. Tilden, D.Sc., Lond., F.R.S.

Assistant Lecturer.—W. W. J. Nicol, M.A. B.Sc., Edin.

Demonstrator.—G. H. Morris, Ph.D. F.C.S.

Elementary Course.

Twenty Elementary Lectures adapted to the requirements of beginners will be given in the Winter Term, and will be repeated after Christmas, on Mondays and Fridays at 12 o'clock. The Second Course will begin on the first Monday in March.

Persons entirely unacquainted with Chemistry are recommended to attend these Lectures before entering for the General Course, which commences in October. Candidates for the Matriculation Examination of the University of London may obtain the instruction they require for that Examination by attending this Course.

General Course.

The General Course of Lectures on Chemistry will be found useful by Students who are afterwards to become Engineers, Architects, Builders, Brewers, or Manufacturers (such as Metallurgists, Alkali Soap, Manure, Glass, or Cement Makers, Bleachers and Dyers, &c.)

Students preparing for the Intermediate Examination

in Science and Preliminary Scientific (M.B.) Examination of the University of London, should attend the Lectures on *Inorganic Chemistry* (Winter and Spring Terms).

Candidates for B.Sc. and Intermediate Examinations in Medicine will in general require only that part of the course (Summer Term) which relates to *Organic Chemistry*.

The full course, extending over three terms, will also satisfy the requirements of Students preparing for the Associateship of the Institute of Chemistry, so far as attendance at lectures on General and Theoretical Chemistry is concerned.

1. From October to March (Winter and Spring Terms). About one hundred lectures on *Inorganic and Elementary Organic Chemistry* will be given on Mondays, Tuesdays, Wednesdays, Thursdays, and Fridays, at 10 a.m., commencing Wednesday, October 4th, 1882. Fee, £3 3s. for a single term, or £5 5s. for the course from October to March.

2. April to June Summer Term. About forty lectures will be given on *Organic Chemistry*, or the chemistry of the most important series of carbon compounds. This course will include all the subjects required for the Intermediate Examination in Medicine of the University of London. Lecture Days.—Monday, Tuesday, Wednesday, and Thursday, at 10 a.m. Fee, £2 2s., or to those Students who have attended the first part of the general course, £1 1s.

In both these courses the instruction at least once a week will take the form of class teaching, and exercises will be set which students will be expected to work at home.

Laboratory Practice.

The College Laboratory will be open daily from 9.30 to 5, except on Saturdays, when it will be closed at 1 p.m.

Candidates for Intermediate Examination in Science, Preliminary Scientific (M.B.), B.Sc., and Intermediate Examination in Medicine of the University of London, may obtain in the Laboratory of the College the instruction necessary. The three months Course of Practical Chemistry for the B.Sc., Edinburgh, in the department of Public Health may be taken in the Mason College Laboratory.

The Ordinary Course for Medical Students is given on Tuesdays and Thursdays from 2 to 4 p.m. throughout the Summer Term.

Fees:—

	All day.	Three hours per day.
One Term	7 guineas	4½ guineas.
Two Terms	13 "	8½ "
Three Terms	18 "	12 "

A Course of short demonstrations and exercises will be given by the Professor or one of his Assistants once a week. All first-year Students will be required to attend, unless exempted for special reasons by the Professor. No Fee.

Metallurgy.—A Course of about twenty Lectures will be given in the Winter and Spring Terms (October to March), on Tuesday Afternoons at 2 o'clock, on the Principles and Practice of Metallurgy. Fee for the Course, £1 1s.

Arrangements will be made in the Chemical Laboratory or giving instruction in Practical Metallurgy.

Excursions.

During previous Sessions permission has been obtained to visit some of the great factories in or near Birmingham, in which chemical and metallurgical industries are carried on. Students have thus had most valuable opportunities of gaining a practical acquaintance with some branches of Applied Science. The privilege thus courteously granted by several manufacturers will, it is hoped, be enjoyed in every future Session. The excursions will be conducted by the Professor.

UNIVERSITY COLLEGE, LIVERPOOL.

Professor.—Campbell Brown, D.Sc.

The Session commences October 2nd. The Chemical Laboratories have been enlarged so as to accommodate 70 Lecture Students and 48 Working Students; further large extensions are in contemplation, and will probably be commenced very shortly.

Students desirous of having a thorough theoretical and practical acquaintance with Technical Chemistry, or who intend to adopt Chemistry as a profession, must devote at least three years to special study. They ought to have an ordinary school acquaintance with English Composition and Latin, and must be proficient in Arithmetic and the elements of Algebra.

They are recommended to adopt the following curriculum:—

First Year.—Chemistry—Course of Lectures on Theoretical Chemistry during the Autumn and Lent Terms; Chemical Laboratory, two or three days a week, during the Lent and Summer Terms; and the Practical Chemistry Class during the Summer Term. Mathematics, Pure and Applied, Physics or Geology, French or German.

Second Year.—Chemistry—Second Attendance on General Lecture Course, if necessary; Lectures on Organic Chemistry in the Summer Term. Chemical Laboratory, three days per week. Physics, Mathematics, German or French.

Third Year.—Any of the above-mentioned lectures which have not been attended. Chemical Laboratory, four or five days per week. Physical Laboratory, one day per week.

Special Certificates will be granted to those Students who pass through the above or a similar curriculum, and who perform their work and pass the periodical examinations to the satisfaction of the Professors; but these Certificates of Proficiency will only be given to such as can perform Practical Work in a reliable manner. Remunerated appointments are occasionally offered to efficient Students of the third year.

The Laboratory is opened for Students from 10 a.m. to 4.30 p.m. daily, on Saturdays from 10 to 1 only.

The Prospectus containing full particulars may be obtained of Adam Holden, 48, Church St., Liverpool, price 6d.

LIVERPOOL COLLEGE OF CHEMISTRY.

Lecturers.—George Tate, Ph.D., F.C.S., and Granville H. Sharpe, F.C.S.

The Session commences October 2nd, on and after which day the Laboratories will be open for practical instruction from 10 a.m. to 5 p.m.

Courses of Evening Lectures will also be delivered on Chemistry, Physics, Geology, Mineralogy, Agriculture, Metallurgy, Brewing, and the Alkali Manufacture.

For further particulars apply to the Principals.

UNIVERSITY OF DURHAM.

COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—P. Phillips Bedson, D.Sc., F.C.S.

Demonstrator.—J. T. Dunn, B.Sc.

The Session will commence on October 2nd, 1882.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Elements of Organic Chemistry. Mondays, Wednesdays, and Fridays, at 12.5 p.m. **Senior Division.**—Organic Chemistry. Elements of Applied Chemistry, including Chemical Mineralogy and Analysis. Tuesdays and Thursdays, at 11. Fee, £5 5s.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. **Laboratory Fees.**—Students

working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Courses of Study.—Students will be distinguished into Regular and Occasional. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Occasional Students will attend such classes as they may select. Every candidate for admission as a regular student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Senior Examination of Persons not Members of the University, held in June.
2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science, will be required to satisfy the examiners in three, at least, of the four subjects.—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises:—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises:—Elements of Organic Chemistry and Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of the value of £25, £15, and £10 respectively will be awarded in October next to Candidates desirous of attending the first year course of study in the College.

Candidates must send their names to the Secretary, on or before the 23rd of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, the 2nd October.

Two Exhibitions of £15 each will be awarded at the next examination of "Persons not members of the University," which will be held at Durham, and elsewhere, in June next.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Mr. W. C. Williams, F.C.S., D.Sc., and Watson Smith, F.C.S.

The Session begins on October 3, 1882, and ends on June 22, 1883.

Technological Chemistry.

Persons desiring to attend this course will be required to enter the College under the ordinary conditions of studentship.

The object of this course is to offer to students intending to devote themselves more especially to Applied Chemistry as complete a training as the College can provide in those branches of instruction which form the scientific foundation of the subject.

The complete course of instruction extends over four years, and embraces the following subjects:—

First Year.—Chemistry Lectures, Junior and Tutorial classes. Chemical Laboratory, 2 days per week, and Analytical Chemistry Lectures class. Mathematical class, Section I. Experimental Mechanics. Geology (Stratigraphical). French or German. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Second Year.—Chemistry Lectures, Junior,* Senior, and Tutorial classes. Chemical Laboratory, 3 days per week. Technological Chemistry Lectures. Experimental Physics or Mineralogy Lectures. German or French. Geometrical Drawing Lectures (evening class). Mechanical Drawing, Practical (evening class).

Third Year.—Chemistry Lectures, Senior* and Tutorial classes. Organic Chemistry Lectures. Chemical Philosophy. Chemical Laboratory, 3 days per week. Technological Chemistry. Physical Laboratory, 1 day per week, or Practical Mineralogy and Technological Mineralogy. Mechanical Drawing, Practical (evening class).

Fourth Year.—Organic Chemistry Lectures.* Technological Chemistry. Chemical Laboratory, 4 days per week. Chemistry of Colouring-Matters, Dyeing, and Calico-Printing (4th evening course). Mechanical Drawing, Practical (evening class).

Fees.—First year (including College Admission and Library fees), £29 5s.; second year, £27 13s.; third year, £28 10s. 6d.; fourth year, £23 19s. 6d.

The aggregate of the fees in each year will vary slightly according to the particular class selected in French or German, or to the choice made in respect of the other alternatives proposed.

When a student is excused a second attendance on any of the Chemistry Lecture Courses the fee will be reduced accordingly.

Certificates will be granted to students on the successful completion of this course. Attendance on the full course of four years is expected of candidates for the Certificate, but students may obtain exemption (on cause shown) from the first or the first and second year's course. Students so excused will nevertheless be required to undergo examination in all the subjects specified.

The Certificate will state in which subjects the candidate has gained Honours, and in which he has merely satisfied the Examiners.

Entrance Exhibitions.

- I. Victoria Exhibition (Classics), £15.
- II. Wellington Exhibition (Greek Testament), £15.
- III. Dalton Mathematical Exhibition, £15. Renewable for a second year.
- IV. Grammar School Scholarship, £17 per annum, tenable for three years; open to scholars of the Manchester Grammar School only.
- V. Two Oxford and Two Cambridge Local Exhibitions, giving free admission to lecture classes in the College for one year, and renewable for two years further, are awarded

* Students who gain a place in the First or Second class in the annual examinations will be excused a second attendance on these classes.

annually on the results of the Oxford and Cambridge Examinations held in Manchester in December, 1880, and June, 1881.

VI. Gilchrist Scholarship, £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London, in June, 1881.

VII. Rumney Scholarship, £45 per annum, tenable for three years.

VIII. Ramsbottom Scholarship, £40 per annum, tenable for two years. The next competition will take place in 1882.

IX. Crace-Calvert Scholarship, £25 per annum, tenable for two years. The next competition will take place in June, 1882. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College. The next competition for the Fellowship will take place in 1881.

Scholarships.

The following (except the Shakspeare Scholarship) are open to the competition of students of the College only.

I. Victoria Scholarship (Classics), £40 per annum, tenable for two years.

II. Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

III. Shuttleworth Scholarship (Political Economy), £50, tenable for one year.

IV. Shakspeare Scholarship (English Language and Literature), £40 per annum, tenable for two years.

V. Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

VI. Dalton Chemical Scholarships, two, each of £50 per annum, tenable for two years.

VII. Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

VIII. Platt Scholarships (Physiology), two, one offered annually, £50 per annum, tenable for two years. (Two Platt Physiological Exhibitions of £20 each are offered for competition at the end of the Session 1880-1, open to first and second years' students in Physiology.)

IX. Heginbottom Physical Scholarship, £30 per annum, tenable for two years.

X. Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

I. Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

II. Classical Prizes.—Essay, value £5. Junior Class Prizes, value £5 and £2 10s.

III. Shuttleworth History Prize, value £5.

IV. English Essay and Poem Prizes, each of the value of £5.

V. Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

VI. New Shakspeare Society's Book Prizes.

VII. Cobden Club Book Prizes (Political Economy).

VIII. Dalton Natural History Prize, value £15.

IX. Engineering Essay Prize, value £5.

UNIVERSITY COLLEGE, NOTTINGHAM.

Professor of Chemistry—Frank Clowes, D.Sc. Lond., F.I.C., F.C.S.

Demonstrator—Mr. J. B. Coleman.

Lecture Course.—A systematic course of morning lectures is delivered on Tuesday and Thursday mornings at

10 o'clock: the non-metals are treated of in the Autumn Term (2nd October to 16th December), the metals in the Spring Term (15th January to 31st March), and the carbon compounds in the Summer Term (23rd April to 7th July).

A course of evening lectures runs parallel with the morning course, being delivered on Wednesday evenings at 8 o'clock.

A tutorial class in connection with both courses meets on Wednesday evenings at 7 o'clock.

Students may qualify themselves by attendance at these lectures and classes for the Examinations of the London University, or for the Cambridge or Oxford University Extension Examinations: they may also obtain instruction in Chemistry for technical or other purposes.

Fees.—For morning lectures, one guinea per term; for evening lectures, 2s. 6d. per term; or 5s. for lectures and classes.

Practical Chemistry.—The chemical laboratory is open on Monday, Wednesday, and Friday mornings from 10 to 1, on Thursday afternoons from 3 to 6, on Tuesday evenings from 6.30 to 9.30, and at other times by arrangement. Each Student works independently of other Students at a course recommended by the Professor. Instruction is given in Chemical Analysis, and in Experimental and Applied Chemistry. A set of ordinary apparatus and reagents and a private locker are supplied free of charge, for the safe keeping of which the Student is held responsible; no extra charge is made for the use of gas and water, and of the cheaper chemicals.

Fees.—For Day Students, one guinea per term for each three hours weekly; for Evening Students, half-a-guinea per term.

Pharmaceutical Chemistry.—A course of lectures suited to Students for the Minor Examination of the Pharmaceutical Society is delivered throughout the Session at 8 on Monday evenings. Pharmaceutical Students are also admitted to the Chemical Laboratory at any time by arrangement with the Professor.

Fees.—For lectures, 3s. 6d. per term; for laboratory work, half-a-guinea per term for each three hours weekly.

Students in the Government Classes work under the direction of the demonstrator on Monday, Tuesday, and Thursday evenings.

All classes of Students are eligible to attend without distinction of sex. For other information Students are referred to the College Calendar.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry and Experimental Physics.—T. Carnelley, D.Sc.

The Session will commence on Tuesday, October 3, 1882.

First Year's Course.—Chemistry of the Non-Metallic Elements. Tuesday, Thursday, Saturday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Chemistry of Metals: Organic Chemistry. Monday, Wednesday, Friday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Laboratory.—Working hours to be arranged between Professor and Students.

Sessional Fees for Day and Evening Students.—Four hours per week, £3 4s.; Six, £4 8s.; Eight, £5 12s.; Ten, £6 16s.; Twelve, £8; Fifteen, £9 14s.; Eighteen, £11 4s.; Twenty-four, £14; Thirty, £16 16s.; Thirty-six, £19 2s.; Forty-two, £21.

Day Students may not enter for less than six hours a week.

Students joining the Laboratory at or after Christmas will be charged two-thirds, and at or after Easter one-third of the Fees for the whole Session.

Fees for short periods.—For one month, £3 13s. 6d.; two months, £6 6s.; three, £9 9s.; four, £12 12s. 6d.; five, £14 3s. 6d.

Evening Classes.—Lecture, Tuesday, 7 to 8; Class, 8 to 9. Fee, 5s. per term, or 9s. per two terms. Laboratory instruction, Wednesday, 7 to 9. Sessional Fee, £2

(Students joining the laboratory at Christmas will be charged half the fee for the whole Session).

UNIVERSITY OF EDINBURGH.

Professor.—A. Crum Brown, F.R.S.E.

The Session will commence on October 25, 1882.

Two degrees in Science are conferred by the University of Edinburgh, viz., Bachelor of Science (B.Sc.) and Doctor of Science (D.Sc.). Both these degrees are conferred in Physical and Natural Science, in Public Health, and in Engineering.

Candidates for degrees in Physical and Natural Science must pass a preliminary examination in English, Latin, Arithmetic, the Elements of Mathematics, and the Elements of Mechanics, and in at least two of the following subjects:—Greek, French, German, Higher Mathematics, Natural Philosophy, Logic, and Moral Philosophy.

The First B.Sc. Examination embraces Mathematics, Natural Philosophy, Chemistry, Zoology, including Comparative Anatomy, and Botany. The Second B.Sc. Examination the Higher Higher Mathematics, Natural Philosophy, Experimental Physics, Chemistry, Zoology, Botany, Physiology, and Geology.

The D.Sc. Examination embraces Mathematics, Applied Mathematics, Experimental Physics, Practical Astronomy, Chemistry, Zoology and Comparative Anatomy, Animal Physiology, Botany, and Geology, including Palæontology and Mineralogy.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.

Chief Assistant.—John M'Arthur.

Laboratory Assistant.—James B. M'Arthur.

Class Tutor.—Joseph Sayers.

Junior Assistants.—Thomas Barbour, Robert Anderson, Archibald Kling.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10 to 11, commencing on Wednesday, Nov. 1st. The Lectures up to the end of the year are devoted to the elements of Chemical Philosophy and to the Chemistry of the Non-metallic Elements. After the new year the Course divides into two branches, viz., the Chemistry of the Metals (on the Mondays and Tuesdays) and Organic Chemistry, select chapters (on the Wednesdays, Thursdays, and Fridays). Six written examinations are held during the Session, which all the members of the class are required to attend.

Fee, £2 2s.

The Laboratory for Practical Instruction in all branches of analysis, including technical assaying, and for original research is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturday also until 11 p.m. The teaching is conducted on the tutorial system, each student working by himself and on his own subject. The Laboratory is furnished with all the necessities for chemical investigation.

Fee for the Winter Session, £10 10s.; Summer Session, £6 6s.; two sessions, if paid in advance, £15 15s., or £2 2s. per month.

A Special Practical Class for Medical Students, meeting twice a week during the Summer Session.

Evening Lectures, commencing on Friday, Sept. 29th, at 8 p.m.

THE

"YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.

Senior Assistant.—Mr. J. Snodgrass.

Junior Assistant.—Mr. B. Hunt.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

LECTURES.—Principal Course.—A Course of Twenty-five Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 6th. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. These Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results, as illustrated in Chemical Technology.

Fee for the Course, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalterers, and others interested in a knowledge of Technical Organic Chemistry.

Fee for the Course, Two Guineas.

Special Subject.—The Professor will deliver a Course of Twenty-five Lectures on Bleaching, Dyeing, and Printing. The Course will commence about the middle of October; and the Lectures will be delivered on Monday evenings, at 8 p.m. These lectures will qualify for the examinations of the City and Guilds of London Institute.

Fee, One Guinea.

Iron and Steel Manufacture.—Mr. J. Snodgrass, F.C.S., Registered Teacher in the City and Guilds of London Institute, will deliver a Course of Evening Lectures on the above Subject, in time for the May Examination. Further particulars will be subsequently announced.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings, immediately contiguous to the former site, are now erected and occupied. They comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories for Technical Research.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

Memorandum as to Bursaries.

The Trustees of the "Young" Chair have the superintendence of the Bursaries—regulating the appointment and terms on which they shall continue to be held.

The Nominees of Donors to be appointed if they pass the necessary examinations.

The Bursaries are of the amount of £50 each per annum, tenable for three years, during which the Bursars shall be required to give their whole time and attention to the Lectures and Laboratory duties of the "Young" Chair, paying the ordinary fees. Candidates to have attained sixteen years of age on application, to be of good moral character, and to pass such examinations as may be prescribed by the Trustees in the ordinary branches of an English education and the elementary principles of Chemistry. The Bursaries to be liable to forfeiture on the Bursars failing to exhibit approved progress under the Professor of the Chair, or being guilty of conduct, in the

opinion of the Trustees, unworthy of their position. The Bursaries are only given to those whose means are limited, and who intend following some branch of Manufacturing Chemistry.

QUEEN'S COLLEGE, BELFAST.

Professor.—E. A. Letts, Ph.D., F.R.S.E., F.C.S.

The Session begins October 17th.

I.—*Chemistry.*—The lectures are delivered at 3 p.m., on the first five days of each week during the College Session. The course is divided into three parts:—(1) Chemical Philosophy; (2) Inorganic Chemistry; (3) Organic Chemistry. In addition to the ordinary lectures, there will be additional ones—partly on Elementary, and partly on advanced Chemistry.

II.—*Practical Chemistry.*—In this course the Students are instructed in the general methods of conducting Chemical Analyses.

III.—*Laboratory Pupils.*—The Chemical Laboratory is open during the College Session on the first five days of the week, from 10 a.m. until 3 p.m. The course of instruction is under the direction of the Professor of Chemistry, and of the Chemical Assistant. Students are admitted as working pupils on payment of a fee of £10 for the College Session, or of £3 10s. for one term.

QUEEN'S COLLEGE, CORK.

Professor.—Maxwell Simpson, D.Sc., M.D., F.R.S., &c.

The Session begins October 17th. The Chemistry Classes are held on Mondays, Wednesdays, and Fridays.

The Course is divided into Inorganic and Organic Chemistry.

In the first part are discussed the Laws of Combination and Affinity, Molecular Chemistry and Crystallography, and the History of the Non-Metallic and Metallic substances.

In the Organic portion of the Course will be considered the subjects of Organic Analysis, Organic Series, Compound Radicals and Types, Metamorphosis of Organic Bodies, History of Special Animal and Vegetable Bodies.

In treating of the Laws of Chemistry, and the History of Inorganic and Organic Bodies those points will be chiefly dwelt upon which have a practical bearing in the Arts, Medicine, Engineering, and Agriculture. Thence, during the Course, attention will be directed to the application of Chemistry to Medicine and Physiology, to Metallurgic Operations, Chemical Manufactures, Building Materials, Soils, and Manures.

Fee.—For each Sessional Course, £2. Each subsequent Course in Medicine, £1.

The Chemical Laboratory is open daily except on Saturdays, from 10 to 4 o'clock, under the Superintendence of the Professor, to Students desirous of prosecuting an extended course of qualitative and quantitative analysis, and for the purpose of original investigation in connection with the Arts, or in the higher departments of Scientific Chemistry.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, STEPHEN'S GREEN, DUBLIN.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Session commences on Monday, October 2, 1882.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions

attached to the College, of the yearly value of £50 each with Free Education, including Laboratory Instruction, tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

Evening Classes.—Systematic Courses of Evening Lectures are given by most of the Professors throughout the Session.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

CITY AND GUILDS OF LONDON INSTITUTE FOR THE ADVANCEMENT OF TECHNICAL EDUCATION, Cowper Street, Finsbury.—Session commences October 3, 1882. Day and Evening Lectures and Laboratory instruction.

CITY OF LONDON COLLEGE, 52, Leadenhall Street, E.C.—Chemical Lecturer—Dr. A. C. Maybury. The courses of lectures are as follows:—

Elementary Electricity	Mondays,	6.30—7.30.
Elementary Chemistry	"	7.30—8.30.

The Session will commence on Monday, October 2. Fee, 6s. per term; per session, 15s.

These classes are specially arranged for Students preparing for the Science and Art Department Examinations, Matriculation, Chemists' Assistants, Teachers, &c.

CRYSTAL PALACE COMPANY'S SCHOOL OF ART, SCIENCE, AND LITERATURE. SCHOOL OF PRACTICAL ENGINEERING.

Principal.—Mr. J. W. Wilson, Assoc. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articulated, who desire instruction in either the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best to utilise the means at their disposal, especially when entirely dependent on their own resources.

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, &c., so that education of the highest class might be afforded on reasonable terms under most advantageous conditions. The system of tuition is, for some subjects, in the manner of private tutorial instruction by the best masters, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Examination for Women, and for the Cambridge Higher Local Examination. The following examinations will be held in the Ladies' Division during 1882-83:—Cambridge Local, December, 1882; Oxford Local and Oxford Examination for Women, June, 1883; Cambridge Higher Examination, June, 1883. The session opens on October 1.

CHARTERHOUSE INSTITUTION.—The Session commenced September 16, under the presidency of the Rev. Henry Swann, M.A. Lectures and Practical Work in a well-fitted laboratory capable of holding 60 students.

Chemical Schools and Colleges.	Winter Session.		Summer Session.	
	Lecturers on Chemistry.	Days and Hours.	Lecturers on Chemistry.	Days and Hours.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. P., 9	Dr. Russell	M. Th. P., 11 to 1
Charing Cross Hospital and College	Mr. Haddon	M. W. P., 4 to 5	Mr. Haddon	M. Th. P., 1 to 4
St. George's Hospital ..	Mr. Jackson	Tu. Th. S., 11 to 7	Mr. Jackson	Th. W. P., 10 to 7
St. Guy's Hospital	Dr. Stevenson	Tu. Th. S., 11 to 7	Mr. Stevenson and Mr. Thomson	M. W. Th., 10 to 6
King's College and Hosp.	Mr. Bloxam, F.R.S., and Mr. Johnson	M. W. Th., 10 to 6	Mr. Bloxam and Mr. Johnson	M. W. Th., 10 to 6
London Hospital	Dr. Tidy	M. W. P., 10 to 7	Dr. Tidy	M. Th. S., 9 to 5
St. Mary's Hospital ..	Dr. Wright	M. Th., 10 to 7	Dr. Wright	W. P., 10 to 4
Middlesex Hospital ..	Mr. W. Foster	M. W. Th. P., 9 to 6	Mr. W. Foster	M. W. P., 1 to 4
St. Thomas's Hosp. & Sch.	Dr. Berridge	Tu. Th. P., 10 to 7	Dr. Berridge	M. Th. P., 10 to 6
University Col. & Hosp.	Dr. Williamson	Daily (ex. S.), 11 to 7	Dr. Williamson	D. (ex. M. S.), 11 to 5
Westminster Hospital ..	Dr. Dupré, F.R.S., and Mr. O. Hehner, F.R.S.	W. Th. P., 3 to 6	Dr. A. Dupré and Mr. O. Hehner	M. W. P., 10 to 4

BIRKBECK LITERARY AND SCIENTIFIC INSTITUTION.
Southampton Buildings, Chancery Lane. — **Inorganic Chemistry.** Lectures:—Elementary, Tuesdays, 8.30 to 9.30; Advanced, Saturdays, 7 to 8. Practice:—Elementary, Saturdays, 4 to 6; Advanced, Saturdays, 8 to 10. Teacher, Geo. Chaloner, F.C.S. **Organic Chemistry:**—Course of Thirty Lectures will be given on Tuesday evenings, at 7 o'clock, by Mr. H. Chapman Jones, F.C.S., commencing on October 3rd. **Practical Organic Chemistry:**—This Class will meet in the Laboratory of the Institution, under Mr. Chapman Jones's direction, on Saturdays from 4 to 6 and from 8 to 10 p.m.

BERNERS COLLEGE OF CHEMISTRY AND THE EXPERIMENTAL SCIENCES, 44, Berners Street, W.—Prof. E. V. Gardner, F.A.S., M.S.A. The Laboratory is open morning and evening throughout the year. A practical School

of Science of a private character; the Courses of study are carried on by private class lectures in the various subjects, and by private Courses of study. These Courses are limited as to time, but are continued so long as is necessary to the Complete practical study of the subject or subjects by the Pupil or Pupils. The studies embrace the Experimental Sciences and Chemistry—Agricultural, Technical, and Analytical; the Science and Practice of Photography, Steam, Telegraphy, Electricity, Magnetism, and Galvanism, the Natural Sciences of Mineralogy, Geology, and Botany. The preparation of Gentlemen for the various Examining Boards and investigations connected with Patents are prominent features of the work of this College.

NEW CENTRAL SCHOOL OF CHEMISTRY AND PHARMACY, 173, Marylebone Road, London.—Mr. A. P. Luff, F.I.C., F.C.S., and Mr. J. Woodland, F.C.S., M.P.S. In addition to the usual Chemical studies, Special Instruction **Classes** are held for Students of Medicine.

ONSLOW COLLEGE OF SCIENCE, 183, Kings Road, Chelsea, S.W.—Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical and Physical Laboratory is open every evening for practical work from 7 to 10 p.m. Principal, Mr. W. H. Martin.

7 to 10 p.m. Principal, Mr. W. H. Martin.

SCHOOL OF PHARMACY OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, 17, Bloomsbury Square.—The school opens on Monday, the 2nd of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment. They are specially designed for the student of Pharmacy, but are equally well adapted for the acquirements of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. *Council Prizes.*—At the end of each of the five months' Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, a Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session only.

SOUTH LONDON SCHOOL OF CHEMISTRY, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Sixty Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

ST. JOHN'S TRAINING COLLEGE, Battersea.—Both Theoretical and Practical Chemistry form part of the curriculum of the College. Lecturer, Alfred Senior, M.D., F.I.C., F.C.S.

THE WESTMINSTER COLLEGE OF CHEMISTRY AND PHARMACY, Trinity Square, S.E.—Messrs. Wills and Wootton. Daily, at 10 a.m. Theoretical and Practical Chemistry. Also Evening Classes, at 7.

BIRMINGHAM.—**QUEEN'S COLLEGE.**—In connection with this College the Chemistry Lectures are given at Mason Science College, by Prof. W. A. Tilden.

—J. Campbell Brown, D.Sc. Lond., F.C.S.

1. **Campher Brown, D.Sc. Lond., F.R.S.**
INSTITUTE OF TECHNICAL CHEMISTRY, Philadelphia
Chambers and Ashton Chambers, Hackin's Hey, Liver-
pool.—Mr. A. Norman Tate. The laboratories have
 lately been entirely re-arranged and considerably extended,
 and are provided with all appliances necessary for
 analytical investigations, special technical examinations,
 and students' work.

LEEDS SCHOOL OF MEDICINE.—Prof. T. E. Thorpe, Ph.D., F.R.S.

LEEDS MECHANICS' INSTITUTION.—Mr. G. Ward, F.C.S. Evening Classes.

QUEENWOOD COLLEGE, near Stockbridge, Hants.—Dr. H. Wilson Hake, F.C.S., F.I.C. Lectures on Inorganic Chemistry and Physics and Laboratory Instruction. Principal, Mr. C. Willmore.

SALFORD WORKING MEN'S COLLEGE, EVENING CLASSES.—Teacher of Chemistry, Mr. G. H. Hurst. Lectures on Organic and Inorganic Chemistry and practical laboratory instruction.

SHEFFIELD SCHOOL OF MEDICINE.—Mr. A. H. Allen, F.C.S. A course of Fifty-six Lectures on Inorganic and Organic Chemistry is delivered by Mr. Alfred H. Allen. The Summer Course of Practical Chemistry is under the direction of Mr. A. H. Allen.

SHEFFIELD BOROUGH ANALYSTS' LABORATORY, 1, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

WESLEY COLLEGE, SHEFFIELD.—Lectures on Chemistry and Physics, by Mr. A. H. Allen, F.C.S., and on Natural Philosophy, and Natural Science by the Rev. W. H. Dallinger, F.R.S.

UNIVERSITY OF ABERDEEN.—Mr. J. S. Brazier, F.C.S. DUNDEE LITERARY INSTITUTION CHEMICAL AND PHYSICAL LABORATORY.—Lecturers on Chemistry, Mr. Frank W. Young, F.C.S., and Mr. John Thomson. Classes and Evening Lectures daily.

SCHOOL OF MEDICINE, SURGEON'S HALL, EDINBURGH.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, Mr. Drinkwater, and Mr. Buchanan.

SCHOOL OF PHARMACY AND CHEMISTRY, EDINBURGH.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Chemistry, Mr. Drinkwater, F.C.S., L.R.C.P.; Materia Medica and Pharmacy, Dr. Urquhart; Botany, Mr. J. McFarlane. Day and Evening Classes.

MINTO HOUSE MEDICAL SCHOOL, CHAMBERS STREET, EDINBURGH.—Mr. J. Falconer King, F.I.C., F.C.S. Lectures and Classes.

NEW VETERINARY COLLEGE, GAYFIELD HOUSE, EDINBURGH.—Dr. Stevenson Macadam and Mr. Falconer King, F.C.S.

GLASGOW UNIVERSITY.—Prof. J. Ferguson.

GLASGOW VETERINARY COLLEGE.—Professor Cooke, F.C.S.

COLLEGE OF SCIENCE AND ARTS, GLASGOW.—Mr. R. R. Tatlock, F.C.S., and Dr. Clark, F.C.S. Day and Evening Classes.

SCHOOL OF CHEMISTRY, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

CHEMICAL LABORATORY, 180, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

UNIVERSITY OF DUBLIN, Trinity College.—Dr. Emerson Reynolds, F.R.S.

QUEEN'S COLLEGE, GALWAY.—Dr. T. H. Rowney.

MUNSTER AGRICULTURAL AND DAIRY SCHOOL.—Thomas Farrington, M.A., F.C.S.

ROYAL COLLEGE OF SURGEONS IN IRELAND.—Dr. C. A. Cameron, F.I.C. The Laboratories of the College are provided with every appliance for the study of Chemistry, especially in its application to Medicine, Hygiene, and Pharmacy.

DUBLIN, CARMICHAEL COLLEGE OF MEDICINE.—Dr. C. R. C. Tichborne.

DUBLIN, CATHOLIC UNIVERSITY.—Mr. Campbell.

DUBLIN, DR. STEVENS'S HOSPITAL AND MEDICAL COLLEGE.—Mr. McHugh.

MECHANICS' INSTITUTE, Abbey Street, Dublin.—Mr. Clement J. Leaper.

UNIVERSITY COLLEGE, LIVERPOOL.

The SESSION will commence on Monday, October 2nd. EVENING CLASSES on October 9th.

Full Courses of Lectures for all London University Examinations in Arts or Science. Physical, Chemical, and Biological Laboratories. All Classes (except the Medical) open to both sexes on the same terms.

For full details of Classes, Fees, &c., see "Calendar" (price 2s.), published by ADAM HOLDEN, 48, Church Street, Liverpool.

FIRTH COLLEGE, SHEFFIELD.

SESSION 1882-83.

The Session will commence on Tuesday, OCTOBER 3rd. Prospectuses may be obtained on application. The Chemical Laboratory is fitted up with accommodation for instruction in the higher branches of Chemistry, and for research.

The Examination for Entrance Exhibitions (two of £15 each) will be held on SEPTEMBER 28th and 29th. Candidates must not be over 21 years of age. Notice of their intention to compete must be sent to the Registrar not later than September 26th. For further particulars apply to

ENSOR DRURY, Registrar.

EDINBURGH SCHOOL OF MEDICINE, MARSHALL STREET, NICOLSON SQUARE.

The CHEMISTRY CLASSES conducted by Dr. DRINKWATER will be resumed on Tuesday, October 24th. The Lectures will be delivered daily at 10 a.m. The Laboratories are open from 9 a.m. to 5 p.m. Special Classes for Sanitary Chemistry.

Now Ready, No. CV., for SEPTEMBER, Price 1s. 6d.

THE JOURNAL OF SCIENCE.

CONTENTS.

1. Witchcraft, Insanity, and Crime. By Frank Fernseed.
2. Bestiarianism v. Common Sense.
3. Jottings on Odours, and their Recognition. By J. W. Slater.
4. Agricultural Possibilities. By An Old Technologist.
5. Will-o'-the-Wisp again. By W. Mattieu Williams.
6. Experimentation in Biology. By Oswald Dawson.

Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

METROPOLITAN BOARD OF WORKS.

APPOINTMENT OF GAS EXAMINERS.

THE METROPOLITAN BOARD OF

WORKS is about to appoint two Gas Examiners, whose duty it will be to test daily the lighting power, purity, and pressure of the gas supplied in certain districts of the Metropolis, at the testing-places fixed by the Gas Referees. One of the testing-places for which an Examiner is now required is in Wellclose Square, and the other in Graham Road, Dalston. Testings of illuminating power are required to be made three times at least each day, at intervals of not less than one hour, and the hours of testing are fixed from time to time by the Board. The mode of testing the lighting power, purity, and pressure is prescribed by the Gas Referees. The persons to be appointed must have had previous experience such as to qualify them for the work, and this experience must be stated in the letter of application, which should be accompanied by testimonials as to character and competence, and should also state the age of the candidate. The salary attached to the office of Gas Examiner is £100 a year.

Applications must be addressed to the Clerk of the Metropolitan Board of Works, Spring Gardens, S.W. The latest time for receiving applications is 4 o'clock on Thursday, the 5th of October next.

J. E. WAKEFIELD, Clerk of the Board.

Spring Gardens, S.W., September 21st, 1882.

CHEMICAL PUPIL.

A Vacancy will occur in course of a month for a well educated Young Gentleman in one of the largest Laboratories in London. Premium 50 or 100 guineas, for a term of two or three years.—X. Y. Z., CHEMICAL NEWS OFFICE, Boy Court, Ludgate Hill, London, E.C.

YOUNG CHEMIST FOR BRITISH GUIANA.

In consequence of the great number of applications for the above post, replies by letter can only be sent to selected candidates.—F.C.S., 18, Henrietta Street, W.C.

Wanted, by Advertiser, a Situation as Manufacturer in Chemical Works, well up in the manufacturing of Acids, Nitrates of Strontia and Baryta, and all Pyrotechnical and general Chemicals.—Apply, W., 26, St. Stephens Road, Tredegar Road, Bow, E.

UNIVERSITY COLLEGE, LONDON.

FACULTY of SCIENCE, including the Departments of ENGINEERING and CHEMICAL and MECHANICAL TECHNOLOGY.

The SESSION will OPEN on Tuesday, October 3rd.
For detailed Prospectuses of the Courses of Instruction, Exhibitions, Scholarships, &c., apply to the College, Gower-street, W.C.
TALFOURD ELY, M.A., Secretary.

THE LONDON HOSPITAL & MEDICAL

COLLEGE, MILE-END, E.—The SESSION 1882-3 will commence on Monday, October 2nd, 1882, when an Introductory Address will be delivered at the College, by JONATHAN HUTCHINSON, Esq., F.R.S., Senior Surgeon of the Hospital, at 8.30 p.m., to be followed by a Conversation, to which all past and present Students are invited. FOUR ENTRANCE SCHOLARSHIPS, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other Hospital Appointments are free. The resident appointments consist of Five House-Physicians, Five House-Surgeons, and one Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special Entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the metropolis.

MUNRO SCOTT, Warden.

ST. MARY'S HOSPITAL MEDICAL

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THE CHEMICAL NEWS

VOL. XLVI. No. 1102

ON THE ACTIVITY OF OXYGEN AND THE MODE OF FORMATION OF HYDROGEN DIOXIDE

By C. T. KINGZETT, F.I.C., F.C.S.

In their endeavours to explain the production of ozone and hydrogen dioxide in certain processes of oxidation, most chemists have had recourse to the views promulgated by Thénard, Lamont, and others.

R. Lamont supposes† that the production of ozone by the atmospheric oxidation of phosphorus in the presence of water is connected with the uneven quantivalencies of the elements concerned in the reaction. He conjectures that the phosphorus first of all combines with two molecules of oxygen, and then, in order to form the pentoxide, a third molecule of oxygen is split up, leaving an atom of oxygen in the free state, and that this atom then combines with an ordinary molecule of oxygen to create a molecule of ozone. Similarly, Thénard regards peroxide of hydrogen as a product of the oxidation of water by the splitting up of the oxygen molecule into active atoms, one of which combines with and is retained by the water. By the oxidation of phosphorus over water, both ozone and peroxide of hydrogen are obtained as products of the reactions involved, whereas in the oxidation of turpentine and other terpenes over water, ozone does not appear as a product, but only peroxide of hydrogen.

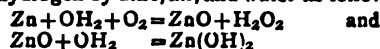
As regards the first-named process, I would observe, in passing, that Lamont's theory is, as I have elsewhere pointed out,‡ faulty, since it does not explain the necessity of the presence of water. If water be absent then a distinct system of chemical changes obtains, thus proving that an explanation to be correct must extend to the water as also to the phosphorus and the oxygen. The oxidation of turpentine is a more simple process, from the point of view here taken, inasmuch as it yields only hydrogen dioxide, and, having been better studied, I propose to dwell rather upon its consideration than that of the other case, while examining some conclusions of M. Traube,§ who has recently experimentally investigated the subject of this communication.

M. Traube finds that when zinc or copper is shaken up with air and water, peroxide of hydrogen is formed, but not active oxygen, which, if present, would oxidise and decolourise indigo-sulphonic acid—a result that is not obtained. He further finds that hydrogen dioxide is alone produced by shaking up zinc with air and ammonia, and contends that no hypothetical active oxygen is obtained, since, if present, it would oxidise the ammonia to nitrite or nitrate, and neither substance is yielded. These results and others are viewed by Traube as satisfactory evidence of the fallacy of Thénard's theory. Curiously enough, however, he overlooks—at least he does not mention—the best existing proof of that for which he contends. This was furnished by my researches upon the oxidation of the terpenes, wherein it was shown|| that turpentine, for instance, first of all simply absorbs the whole molecule of oxygen, just as Soret had shown it to absorb the whole molecule of ozone. There is no evidence of the splitting up of the oxygen or ozone

molecules, but a total absorption takes place, resulting in both cases in the formation of an organic peroxide, which I conjectured might be identical with the camphoric peroxide ($C_{10}H_{14}O_4$), obtained otherwise by Brodie, and it is only by a secondary reaction between the oxidised turpentine and water that hydrogen dioxide is eventually obtained.

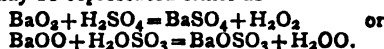
This is clear proof that molecular oxygen taking part in the oxidation of turpentine is not split up into atoms, and is presumptive evidence that it is not split up in the other process to which I have referred, viz., the oxidation of phosphorus.

To revert to the paper of M. Traube. He next proceeds to argue that in the formation of hydrogen dioxide it is water and not oxygen that suffers decomposition, and in confirmation of this view he mentions that the alkali metals, which remain unchanged in dry oxygen, readily decompose water. He also represents the production of peroxide of hydrogen by zinc, air, and water as follows:—



It will be observed that these equations indicate the formation of one molecule of hydrogen dioxide for each molecule of metallic hydroxide produced, but M. Traube does not adduce any quantitative evidence of their correctness, but contents himself with the statement that Schönbein has established a similar relation in the case of lead at the beginning of the reaction. Traube's conjecture, then, is that zinc decomposes water by assimilating an atom of oxygen, and that the hydrogen thus set free simultaneously enters into combination with atmospheric oxygen to form hydrogen dioxide.

I have not yet investigated for myself the oxidation of metals in the manner described by M. Traube, but I feel great difficulty in accepting these views. That zinc should, by virtue of its affinity for oxygen alone, more easily decompose water than unite with free oxygen, is to me difficult of belief; nor can I understand the simultaneous combination of a molecule of hydrogen with one of oxygen taken from the air, as is assumed to take place. However that may be, M. Traube is not altogether happy in his selection of facts adduced for the purpose of lending confirmation to these views. He states, for instance, that the formation of hydrogen dioxide by the action of acids upon the metallic peroxides, does not involve the oxidation of water, but the interchange of the metal with the hydrogen of the acid. It seems to me that we may view at will the process as involving the one change or the other. Thus the action of sulphuric acid upon barium peroxide may be represented either as—



As regards the action of hydrochloric acid it may of course be represented as—



but this equation probably does not represent the actual changes, which may be, perhaps, more reasonably expressed thus—



the peroxide of hydrogen only forming when water is also present, as it always is either attached to the hydrated barium peroxide, or present with the hydrochloric acid, or with both. That this is so, is supported by the decomposition of the barium peroxide in water by means of carbonic anhydride,



It is thus just as easy to understand the direct oxidation of water, always present, as to imagine the replacement of hydrogen by the metal; the only requirement is that water shall be present in chemical contact with the oxygen as and when it is rendered available.

In order to further test the idea of M. Traube, it may be useful to consider again by what steps hydrogen dioxide is obtained from peroxidised turpentine. This last

* Read before the British Association, Southampton Meeting, Section B, 1882.

† CHEMICAL NEWS, vol. xxviii., p. 236.

‡ CHEMICAL NEWS, vol. xli., p. 182.

§ *Berichte*, 15, 659-675; for abstract see *Journ. Chem. Soc.*, August, p. 795.
|| *Journ. Chem. Soc.*, 1873, pp. 210-221.

named substance, by mere contact with water, yields peroxide of hydrogen. Here, oxygen is transferred from the organic peroxide to the water, speaking broadly, and it is not possible to conceive that in this simple process anything like the decomposition of water takes place. We have, probably, either a mere transference of oxygen or a simple re-arrangement of molecules.

In one of my papers (*Journ. Chem. Soc.*, 1875) I have represented the change as follows:—

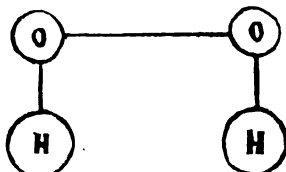


In this equation I assumed the identity of my peroxide with Brodie's body, and endeavoured to explain why a camphoric acid was found present with the peroxide of hydrogen in my solution, and for those immediate purposes the equation well sufficed, even if it be not strictly correct.

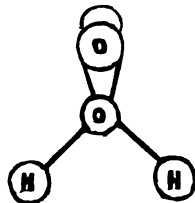
I will not seek to further apply the considerations arising from the study of the oxidation of turpentine to that of phosphorus, but will merely add that, so far, there exists considerable doubt as to the mode of formation of ozone and hydrogen dioxide in that process. Is hydrogen dioxide a secondary product in this system of changes? Probably it is, and probably ozone is also, and, if so, then from what substances do they result, and by what reactions?

The study of turpentine oxidation is at once, as I have said, more simple, and has been better studied, and we may rely upon our knowledge of the process as furnishing strong evidence against the erroneous idea that has been widely held concerning the splitting up of the oxygen molecule and of the fallacy of Traube's conjecture as constituting a general explanation of the mode of formation of hydrogen dioxide.

The study also leads to another and important consideration, and that is the constitution of hydrogen dioxide. In this substance are the atoms of hydrogen severally united with atoms of oxygen, thus?—



or has oxygen a variable adicity? In the latter case, representing oxygen as a tetrad, we might conceive hydrogen dioxide to be an oxide of water—a constitution much more in accordance with its properties, thus—



It is difficult to accept the ordinary formula, and to understand why one atom of oxygen is so readily given up by the compound while the other is so persistently retained, and there is a good deal of general evidence tending to show that the oxygen which is lost in such cases by the substance is the same oxygen as that which by its association with the water molecule, originally produced the peroxide of hydrogen. It is to be noted that although certain metallic oxides are reduced to the metallic state by admixture with peroxide of hydrogen, yet, as shown by M. Berthelot,* the oxygen set free in the case of silver oxide is only equal in amount to that present in the oxygenated water, the residual matter containing the

whole of the silver and oxygen originally contained in the oxide of silver; but the distribution of the elements becomes changed under the action of the hydrogen dioxide, so that the residual compound represents a mechanical mixture, containing one-third of the silver in the reduced state and the corresponding portion of oxygen as sesquioxide of silver.

I think the facts to which attention has been directed in the foregoing remarks says nothing in favour of molecular connection as being something distinct from inter-atomic connection, but they seem to me to indicate that oxygen has a variable adicity or valency—a supposition which I feel more free to espouse, since Professor Odling, in his powerful address to the Chemical Society in February last, has reasoned so strongly in favour of the variable adicity of the chemical elementary substances, or (as I should prefer to style them) the various forms of matter.

REPORT OF THE COMMITTEE ON THE CALIBRATION OF MERCURIAL THERMOMETERS.

On Monday, August 28th, the Report of the Committee on the Calibration of Mercurial Thermometers was laid by Prof. Rücker before Section B of the British Association. Prof. Rücker said that as the report was lengthy, and would be in many parts unintelligible without reference to the Tables and Plates by which it was accompanied, he must ask to be allowed, instead of reading it in full, to give a general account of the work which had been done and of its results. The following is a full report of his remarks:—

In drawing up the Report the Committee have desired to present it in the form in which it will be most generally useful. It is therefore divided into two parts. The first contains a brief outline of the various methods of calibration hitherto proposed, and a summary of the results arrived at with regard to them by the Committee. This portion therefore contains the facts necessary to enable a selection from the various methods to be made by persons intending to undertake the calibration or correction of a thermometer. The second consists of a fully worked-out example of each of the methods, together with critical and other remarks of a detailed character. This part will, it is hoped, be useful in facilitating the calculations required, more especially as references to the subject of calibration in English scientific works are rare and meagre.

The corrections for the inequalities in the bore of a thermometer tube may be applied in two different ways, viz., by *calibration* or *correction*. In the first the tube is studied before the scale is etched on it, and the divisions of the scale are adjusted so as to make equal differences of scale readings correspond to equal tube volumes. In the second the tube is furnished with a uniform scale, and a table of corrections is afterwards prepared by which the same result is attained. A high degree of excellence can be obtained by the former method, which is generally employed by the makers. If, however, great accuracy is desired, all thermometers require correction, and if an instrument has been previously calibrated this process is rendered very laborious by the varying lengths of the divisions which have to be allowed for in the calculations. The results, too, are probably less accurate than they otherwise would be on account of the irregularity of the correction curves produced by the superposition of the errors of the tube and scale. The Committee therefore recommend the use of a uniform millimetre scale, and the employment of such tubes only as preliminary tests have shown to be of fairly uniform bore.

As all the methods of calibration and correction described depend upon the measurement of the length of

* *Comptes Rendus*, No. 11, March 15, 1880.

columns of mercury in various parts of the tube, it is important to decide upon the best method of separating these "threads" (as they are called) from the main mass of mercury in the tube and bulb. In general it is in the first place necessary to make the mercury "run" from the bulb into the tube, so that a column of any length can be obtained when the thermometer is at the ordinary temperature. To effect this the instrument should be held in a vertical position with the bulb uppermost, and the lower end of the tube should be cautiously tapped against the table. If the mercury does not run it is well, as a preliminary, to heat and cool the bulb several times. A change of temperature of a few degrees will generally suffice. The transference of the mercury from the bulb to the tube causes a vacuum bubble to appear in the former. If this is brought to the junction between the tube and bulb it is often possible, in a thermometer with a tolerably wide bore to effect a disruption of the mercury at this point by a dexterous jerk, and thus to break off a thread of the desired length. It is, however, exceedingly difficult, if not impossible, to apply this method satisfactorily to instruments with narrow bores; and in all the experiments undertaken by the Committee the separation of the thread was effected by heat. Some writers recommend the use of the blowpipe flame, which appears unnecessarily risky. The Committee employed a small flame, about four or five millimetres high, obtained from the gas issuing from a narrow orifice at the extremity of a piece of glass tubing drawn out fine. Into this the thermometer was introduced, care being taken to heat the tube equally all round, and the rupture was effected at the point where the heat was applied. It is easy thus to break off threads to within a millimetre of the length desired. When great accuracy is important it is advisable first to break off a thread longer than that required, and then to separate from it a portion of the desired length. Greater steadiness of the mercurial column while the thermometer is being heated is thus attained. Many dozens of thread have thus been broken off within the experience of members of the Committee without a single breakage of the instruments experimented on.

Methods of calibration and correction may be divided into four classes.

The first class contains what may be called the *step by step* method which is due to Gay-Lussac. In it a thread of mercury is measured in a position A B, then shifted to B C, then to C D, and so on through the whole length of the tube, the corrections being deduced from the variations in length.

FIG. 1.

A B C D E F G

The second class contains *principal point* methods. In these a number of principal points separated by an equal number of scale divisions are selected. The corrections are determined for these by means of threads, the lengths of which are approximately equal to, or multiples of, the distance between two consecutive principal parts. Several methods are included in this class. Hällström's, as described by Pfundler, is a modification of Gay-Lussac's, in which an attempt is made to prevent the risk of the cumulation of errors inherent in the use of very short threads. Two threads are used, one twice, the other three times as long as the distance between two principal points. The first is measured in the positions (see Fig. 1) A C, B D, C E, &c., the other in the positions A D and B E only. From these measurements the corrections at A, B, C, &c., can be found.

In M. Thiesen's method (*Carl's Repertorium*, bd. xv.), the scale being divided into n parts by equidistant principal points, threads equal in length to 1, 2, 3 . . . $n-1$ of these intervals are measured with the ends nearest to the bulb, coincident in turn with as many of the selected points as possible, and hence the corrections are deduced. Marek (*Ibid.*, bd. xv.) has applied the method of least

squares to the calculation of the corrections of a number of selected points.

When by any principal point method the scale has been divided into a number of parts, the relative volume-values of which are known, it is of course possible to sub-divide these parts by a number of secondary points. In one method, however (Rudberg's), such sub-division is of the essence of the method, and it therefore constitutes the third class, or method of *repeated sub-division*. Thus (see Fig. 1) the tube is first divided into two equal parts by measuring a thread of about half its volume when it occupies approximately the positions A D, D G. These parts are then sub-divided into three by measuring a thread about one-third of the length of the tube in the positions A C, C E, E G, B D, and D F, and the process can then be carried further.

The last class may be called that of *distributed point methods*. Of these there is only one example, viz., Bessel's. In it the threads are measured with the end nearest the bulb coincident in turn with each of a series of selected points, but as the lengths of the threads are, within wide limits, arbitrary, the other ends do not coincide with the principal points, but are distributed more or less unevenly over the scale.

In the modification of this method adopted by A. von Oettingen ("Ueber die Correction der Thermometer Dorpat," 1865) eight or ten threads are used, and the corrections are finally found by a graphic method. The scale divisions being taken as abscissæ, and the corrections to be applied to them as ordinates, each thread furnishes a correction curve. The curve obtained by taking the mean of the ordinates of these is the final correction curve. This method is in the report subjected to full and detailed criticism. It is open to the objection that by it the ends of the tube are less accurately corrected than the centre. This is especially unfortunate. Thermometers are now often made with scales so open that it requires several to cover the whole range of temperature from 0° to 100° C. Each instrument therefore can have at the most but one fixed point, and to determine the value of a scale division in degrees it is necessary that each thermometer should overlap those above and below it, so that they can be compared over a considerable range of temperature. This range is, however, seldom more than one-fourth of that over which the scale of each thermometer extends, and thus any error which occurs in the determination of the relative value of this overlap in two instruments is magnified in its effects upon the absolute readings of each. It is then important that the ends of such thermometers shall be corrected with especial care, and Profs. Thorpe and Rücker have introduced some changes into Von Oettingen's method of procedure which diminish this defect. The two methods are fully compared in the Report.

In many methods of calibration and correction one or both ends of the thread are, when it is measured, assumed to occupy certain definite positions on the scale. The condition that both ends should occupy their theoretical position could only be fulfilled in a perfectly uniform tube; otherwise, if satisfied in one part it would fail elsewhere. It is, however, often inconvenient even to comply with the condition that one end shall occupy a certain position. If the tube is graduated, and the position in question is indicated by a graduation, the breadth of this is often so considerable that the required accuracy of adjustment cannot be attained if the end of the thread is hidden behind it. Hence it is often better merely to bring the thread end to within a small but accurately measured distance of its theoretical position. The error thus committed can then be allowed for either by means of a second approximation, or by the use of a preliminary correction curve obtained by any simple method. The Report contains full details and examples of these two methods of procedure.

Formulae are given which express the probable error of the correction of a principal point (E) in terms of the

probable error of a thread length (e). If $E = me$, the numbers in Table I. gives the values of m for ten principal points 4° apart, when the methods referred to are employed to find the corrections at them. These numbers are inversely proportional to the theoretical weights which should be assigned to the correction of a point determined by any method if it is to be combined with a similar correction determined by another method.

Thus in the case of Gay-Lussac's method, the value of the correction of a point is, *ceteris paribus*, proportional to the length of the thread used in obtaining it. Rudberg's method corrects the instrument best in the middle,—Gay-Lussac's at the ends. Thiesen's method has the advantage that the value of the corrections is uniform throughout the scale, Hällström's the grave disadvantage that it is very irregular, and that the errors accumulate in an extraordinary way on two of the points.

TABLE I.
Squares of Probable Errors of Principal Points.

Point.	Gay-Lussac:		Rudberg.	Hällström.	Thiesen.	Bessel.
	Thread 2° long.	Thread 4° long.				
0	0.0	0.0	0.0	0.0	0.00	0.00
1	1.8	0.9	1.4	1.1	0.18	0.10
2	3.2	1.6	1.8	0.8	0.18	0.10
3	4.2	2.1	0.7	1.1	0.18	0.10
4	4.8	2.4	0.6	1.2	0.18	0.09
5	5.0	2.5	0.5	2.5	0.18	0.09
6	4.8	2.4	0.6	1.2	0.18	0.09
7	4.2	2.1	0.7	4.3	0.18	0.10
8	3.2	1.6	1.8	0.8	0.18	0.10
9	1.8	0.9	1.4	6.5	0.18	0.10
10	0.0	0.0	0.0	0.0	0.00	0.00

It must be remembered that the numbers in this Table apply only to the case of the determination of ten principal points, and that in calculating them no allowance is made for inaccuracies introduced by assumptions, which are only approximately true, made in the methods themselves.

The experimental work of the Committee has been performed upon twelve thermometers. Two sets of three belonging to Profs. Thorpe and Rücker were made by Casella. The other two sets were made in the Kew Observatory and in the Physical Laboratory of the Owens College respectively. The length of a degree in the different instruments varied from 9 to 13 m.m., and may therefore, in round numbers, be taken as equal to a centimetre.

The Kew thermometers were calibrated according to Welsh's (Gay-Lussac's) method, a good dividing engine being employed. After the scale was etched the same instrument was employed to make all the measurements necessary for the application of Bessel's method to the thermometer. The result of this severe test was reported to Section A last year, viz., that the maximum error barely exceeded 0.01° , and in two of the thermometers fell much below this amount.

The Committee have also tested the various methods by applying them all to the same thermometer, an instrument reading from 98° C. to 142° C. The measurements were made in the Physical Laboratory of the Yorkshire College, partly by Prof. Rücker, partly by Mr. W. Heaton, Demonstrator in the Clarendon Laboratory of the University of Oxford, who spent some time in Leeds for the purpose of assisting in this rather laborious task. Gay-Lussac's method was applied three times, the thread lengths being 1.6° , 2.0° , and 4.0° respectively. The curve obtained by means of the thread 2.0° long was used as above explained as a preliminary curve to allow for the errors introduced in the other methods by the fact that the thread ends did not always occupy their theoretical positions.

The instrument employed was that devised by Mr. F. D. Brown, and described by him in a recent number of

the *Philosophical Magazine* (June, 1882). Readings could be made on the vernier to 0.1 m.m., and by estimation to 0.02 or 0.03 m.m. The probable error of the measures made for the application of Bessel's method, 138 in number, was 0.025 m.m. The Committee thought it well to employ this instrument, as if satisfactory results were obtained its comparative simplicity and cheapness would enable many persons to correct their thermometers who had not the opportunity of using a dividing engine. The result of the investigation showed that it is capable of giving very good results. The following Table gives in thousandths of a degree the corrections obtained for the principal points by the methods indicated. Rudberg's method cannot be directly compared with the others, as it was used to find the corrections at 12 points.

TABLE II.
Corrections given by Different Methods in Terms of 0.001° .

	Gay-Lussac.			Hällström.	Thiesen.	Marek.	Bessel.
	Thread Length.	1.6°.	2.0°.	4.0°.			
100	0	0	0	0	0	0	0
104	121	120	116	120	121	—	120
108	155	155	151	153	156	155	151
112	106	109	104	107	109	—	104
116	108	116	113	115	117	117	115
120	130	136	135	137	138	—	135
124	106	112	111	109	113	112	109
128	108	111	111	114	112	—	108
132	56	60	61	56	61	62	54
136	2	10	12	13	10	—	4
140	0	0	0	0	0	0	0

In estimating the value of the agreements between the various columns in this Table it must be remembered that whereas the two first Gay-Lussac corrections and those given by Bessel's method are quite independent of the others, observations on the same threads were employed in the other methods. All the measurements, for instance, worked up according to Marek's formulæ were also employed in the calculations required in Thiesen's method. It will be seen that the difference between the corrections for the same point only in one instance exceeds 0.01° .

On the other hand, the amount of labour involved in the different methods is very different. Gay-Lussac's method can be applied in a few hours; the observations and calculations necessary for Bessel's occupy six or seven days.

The following Table gives the number of actual measurements required in such method.

Method.	No. of Measures Required.			No. of Points Corrected.	
	(1)	(2)	(3)	(1)	(2)
	Principal Corrections.	Preliminary Curve.	Total.	Principal Corrections.	Total.
Gay-Lussac I.	26	—	26	26	26
" II.	20	—	20	20	20
" III.	10	20	30	10	20
Hällström	11	20	31	10	20
Thiesen	54	20	74	10	20
Marek	14	20	34	5	20
Rudberg	15	20	35	12	31
Bessel	138	—	138	148	148

A detailed discussion of the results arrived at by the different methods, awards, on the whole, the palm to Bessel's, but the Committee consider that equally good results can be obtained with much less labour by repeating Gay-Lussac's method with two or three threads of different lengths, and taking the mean of the curves so obtained. Thus, the mean of the numbers in the first two columns of Table II. nowhere differs from the corresponding number in the last column by 0.005° (0.05 m.m.)

The Committee, for convenience, finally define three standards of accuracy, viz., that the corrected scale shall at no point be in error by 0.1 , 0.05 , and 0.02 m.m. respectively. In the thermometer used these would correspond

to about 0.01°, 0.005°, and 0.002°. They consider that 0.05 m.m. is about the limit of the error of an unassisted-eye reading, and that the second standard is therefore that which will be most generally aimed at for very accurate work. The Report contains details of the methods which the Committee think suited to attain each of these standards with the least trouble. In brief, they state that the first can be reached by a calibration by Gay-Lussac's method conducted with a dividing engine, the second by correcting according to Bessel's method or by the mean of two of Gay-Lussac's curves when the measurements are made with Mr. Brown's instrument, the third can be attained only by the most elaborate methods and apparatus. On the whole, therefore, the result of the investigation is in favour of the repetition of the less elaborate rather than of the use of the more theoretically perfect methods.

THE ACTION OF WATER ON LEAD.

By ALFRED H. ALLEN.

THE article in the *CHEMICAL NEWS*, vol. xli., p. 88, gives an epitome of the recent action by Mr. J. J. Milnes against the Huddersfield Corporation.

As therein stated, at the trial there arose the question of the influence the presence of sulphuric acid had upon the tendency of water to act on lead, and in the words of the article "the water in question was admitted to have an acid reaction. This was due to sulphuric acid, as was shown by Dr. Tidy." I was not present in court while Dr. Tidy's evidence was being taken, and have seen no published account of his examination, but, seeing that the proportion of free acid was very small, it would be interesting to learn how it was proved to be sulphuric acid. That a free acid was present was proved by the fact that the water distinctly reddened a solution of Poirier's orange, and, after concentration, had a distinctly acid reaction to litmus; but it seems very improbable that the trace of acid present was recognisable by its charring action, and, if not, how was it proved to be sulphuric acid? That the free acid originated in the influx of ochreous water containing free sulphuric acid seems to be admitted, but what becomes of free sulphuric acid when added to a water containing several times its equivalent of metallic chlorides? It may reasonably be argued that sulphates are formed, together with free hydrochloric acid, and, until this view is experimentally disproved, most chemists will regard it as probably correct.

Now the presence of a small quantity of free hydrochloric acid admittedly increases the tendency of water to act on lead, and is probably the cause of the influence observed in the case of the Huddersfield water. But, on the other hand, "Dr. Tidy, Prof. Odling, and Mr. Crookes were of opinion that sulphuric acid, if present in small quantities, must tend to protect the pipes from the action of the water, a thin layer of the insoluble, or at least very sparingly soluble, lead sulphate being formed." How far it is reasonable to expect that such protection would be exerted by very small proportions of sulphuric acid may be gathered from a consideration of the relative solubilities of the oxide, carbonate, and sulphate of lead in distilled water, thus,—

	Pb per Gallon.
1 part of PbO dissolves in 7000 parts of water = 9.8 grs.	
1 " PbCO ₃ " 50,500 " " = 1.07 "	
1 " PbSO ₄ " 22,800 " " = 2.09 "	

I am unable to find the solubility of basic lead carbonate, but it is probably less than that of the neutral salt.

It appears, then, from these figures, that distilled water in contact with lead and oxygen might take up 9.8 grs. of lead per gallon, but in presence of carbonic acid, as in most natural waters, this would be reduced to 1.07 grs. In presence of free sulphuric acid, however, shown by Dr.

Tidy to be present, the carbonate would be changed to sulphate, and the possible amount of lead in solution would be nearly doubled. It is true that in presence of a very large excess of sulphuric acid (sufficient to convert the water into "dilute sulphuric acid") the solubility of lead sulphate is somewhat diminished, but that is a state of affairs which does not apply to the Huddersfield water, respecting which the three high scientific authorities quoted expressed an opinion leading the jury to infer that the presence of a trace of free sulphuric acid was rather beneficial than otherwise, as it would "tend to protect the pipes from the action of the water."

But experiment on such a subject is better than theory, and hence I submit the following data on the action on lead of water containing different amounts of free sulphuric acid. The experiments were made by adding to four quantities of 250 c.c. of distilled water a definite volume of decinormal sulphuric acid (= 4.9 grms. H₂SO₄ per litre). Pieces of sheet lead of equal size, scraped clean immediately before use, were then immersed in the liquids, and the beakers loosely covered and left over night.

Expt. I.—Distilled water without any addition of sulphuric acid acted strongly on the lead. The metal was removed, and the white deposit at the bottom of the beaker was dissolved in a few drops of hydrochloric acid, when the water was found to contain 7 grains per gallon of metallic lead.

Expt. II.—To 250 c.c. of distilled water 0.1 c.c. of decinormal sulphuric acid was added. This corresponds to 0.112 grain SO₃ per gallon, or about the quantity of free acid found by Mr. Fairley in the Huddersfield water. The experiment was conducted as in I., when 7 grains of Pb were found, as in the previous case.

Expt. III.—The sulphuric acid was increased to 1.0 c.c. = 1.12 grains free SO₃ per gallon. The lead appeared little acted on, there being no formation of carbonate, but the water was found to contain 1.75 grains of lead per gallon.

Expt. IV.—5.0 c.c. sulphuric acid added, = 5.6 grs. SO₃ per gallon. No apparent action on the lead, but the water contained 1.70 grains Pb per gallon.

In the first two experiments it must be remembered that in the absence of sulphuric acid the lead was converted into carbonate, and hence was not really in solution in the water, but in experiments III. and IV. it existed as dissolved sulphate.

These experiments were made with distilled water, and consequently under conditions that do not exist in practice. Hence the following experiments are of more real value. They were made side by side with those already described, but Sheffield water was substituted for distilled water. Sheffield water is a pure moorland water containing from 5 to 7 grains per gallon of total solids, of which the chlorine is 0.7 grain. The reaction is neutral, or very faintly acid rather than alkaline.

Expt. I.—Sheffield water without any addition of acid took up a trace of lead, less than 0.05 grain per gallon. (In a subsequent experiment 0.10 grain was dissolved.)

Expt. II.—With an addition of 0.112 grain per gallon of SO₃, a strong trace of lead was dissolved, notably more than in Expt. I.

Expt. III.—With 1.12 grains SO₃, 0.28 grain of lead was dissolved.

Expt. IV.—With 5.6 grains SO₃ per gallon, the lead dissolved was 4.9 grains per gallon.

In none of these experiments was there any sensible formation of carbonate, and only the clear liquid was used for the determination of lead. It will be seen that the presence of sulphuric acid, even in very small quantity, notably increases the tendency of the water to act on lead. Repetition of the experiments always furnishes results pointing in the same direction, but the actual figures vary from time to time, being probably influenced by variations in the composition of the water. Thus, previously to the trial, I found the addition of 0.224 gr. SO₃ to 1 gallon of

Sheffield water caused the solution of 0.6 grain of lead per gallon in twenty-four hours, though the unacidulated water dissolved a barely perceptible trace of lead in the same time. It was to this experiment I referred in court as proving that the addition of a trace of sulphuric acid to a pure water (not distilled water) increased its tendency to act on lead.

Since the date of the trial a death has occurred at Keighley, which is suspected by the medical men to be due to lead poisoning through the medium of water. The deceased was in the habit of drawing a glass of water from the tap the first thing in the morning, and by drinking this he would necessarily introduce into his system any lead dissolved from the pipes during the night. In his viscera I found lead. Water which had been standing in the lead pipes all night contained 0.61 grain of lead per gallon. Water taken from the neighbouring main was free from lead, but had a marked acid reaction to Poirier's orange. Left over-night in contact with clean lead it dissolved from 0.42 to 0.56 grain per gallon. Rendered faintly alkaline with lime-water, and left over-night in contact with lead, only 0.14 grain of Pb was dissolved.

These experiments appear to me to indicate that a trace of free acid is a leading cause of the action of water on lead, and that the effect can be greatly diminished by neutralisation.

Occasionally, during a period extending over many years, I have examined the Sheffield water for lead. At present it is wholly free from that metal, even after standing over-night in the pipes, but not unfrequently I have found notable traces of lead. In the light of recent researches it is probable that, on those occasions, the water as delivered from the mains contained a free acid, whether sulphuric acid, or, as I contend is more probable, hydrochloric acid.

Of course the few experiments above described do not wholly clear up the difficult and obscure problem of the cause of the action of water on lead, but they at least indicate the great probability of one of the leading causes, and they help to lay at least one old ghost, and lead to a better understanding of some misinterpreted observations. It remains for others to show why sulphuric acid and sulphates should be theoretically held to reduce the tendency of water to act on lead when lead sulphate is more soluble than the carbonates, and why free sulphuric acid should be assumed to exist in water simultaneously with metallic chlorides.

Sheffield, September 9th, 1882.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Students' Number:—

METALLURGICAL BRANCH OF THE ROYAL SCHOOL OF MINES.—This department will re open on the 2nd of October in a new lecture room and museum, which has been specially arranged for this class by the Science and Art Department at South Kensington. The Theoretical Course will consist of about sixty lectures, by Prof. W. Chandler Roberts, F.R.S., who is now making a careful inspection of the Mining Schools at Freiberg and at Leoben. The third award of the "Bessemer" Medal, and a prize of books, will be made at the end of the Session, in June, 1883. The Practical Course of Assaying is continued throughout the entire Session.

BURSLER AND TUNSTALL SCHOOLS OF SCIENCE AND ART, Wedgwood Institute, Burslem.—Lecturer on Chemistry, Physics, &c., W. A. Humboldt Sexton. Day lectures on Chemistry on Tuesdays and Thursdays at 2.30, and practical instruction in Laboratory after each lecture. October 3rd to Christmas—The Non-metallic Elements. January to March—The Metals. April to June—Organic Chemistry. Technical lectures on Saturday afternoon: Fuel at 3 o'clock; Pottery at 4 o'clock; Metallurgy at 5 o'clock. Evening Classes in Chemistry, Physics, and other subjects.

CHEMICAL LITERATURE.

AN ADDRESS DELIVERED BEFORE THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AT MONTREAL, AUGUST 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

(Continued from p. 117).

AMONG the fabulous writings, highly esteemed by the credulous alchemists, may be mentioned the celebrated inscription of Hermes Trismegistus upon an Emerald Tablet,* the Golden Leaves of Abraham, Jew Prince, Priest, Levite, Astrologer and Philosopher, which, in the hands of Nicolas Flamel,† yielded such a rich harvest, the Practical Chemistry of Miriam, the sister of Moses,‡ and a multitude of grotesque writings ascribed to personages of known reputation. Raymond Lully is credited with five hundred works; Hermes Trismegistus, the mythical Father of Sciences, with several thousand.

Many of the alchemical works published during the period of which we speak are degraded by admixture of the contemporaneous, pseudo-sciences, judicial astrology, and magic. To this class belong the celebrated works of Dr. Fludd and the writings of the Rosicrucians; excluding these as wholly beneath our consideration the number of occult works on alchemy is still very large. We imagine it will be hard to discover in the whole range of literature writings having scientific pretensions more senseless than the aphorisms of the disciples of Pythagoras, collected in the "Turba Philosophorum,"§ so often quoted by the alchemists of the sixteenth and seventeenth centuries. Its improbable character is perhaps equalled by the "Gloria Mundi," in which the anonymous author favours his readers with the chemical views of Aristotle, Plato, Socrates, and Democritus, interspersed with equally authentic statements by Hermes and Morien, Lamech and Methuselah, Abel and Seth, and even of Adam himself.||

In the early part of the seventeenth century, Michael Maier, physician to the Emperor of Germany, Rudolph II., a royal patron of astrologers and alchemists, published several treatises now much sought after by alchemical bibliophiles.¶ Maier's "Symbola aurea mensæ," and "Atalanta Fugiens," contain emblematic plates, supposed to illustrate the hermetic interpretation of the fables and allegories of Egypt and Greece.

The connection between these ancient mythologies and the secrets of the philosopher's stone was a favourite subject with many authors, and has been exhaustively treated by the Abbé Pernety in his two curious works, "Fables Egyptiennes et Grecques dévoilées," and "Dictionnaire Mytho-hermétique."** Not content with prose, several authors clothed their alchemical inspirations in poetry; of these may be mentioned the Arabian treatises already named, the Twelve Gates of Alchemy by Sir George Ripley, written about 1450,†† the Crede Mihi of Thomas Norton, written about 1477,‡‡ and the Chrysopoeia of Aurelius Augurelli.§§ The latter written in

(Works marked (a) are in the private library of the author).

* Cf. (a) Thomas Thomson, "History of Chemistry," London, 1830, vol. 1, p. 10.

† Cf. (a) Nicholas Flammel, "His Exposition of the Hieroglyphical Figures," London, 1624.

‡ In the Collection of (a) Johann Hoppodam, Wien, 1740, also in Barrett's Lives, loc. cit.

§ Cf. (a) Mangetus, *Bibliotheca chemica curiosa*, vol. 1, p. 400, also (a) *Bibliothèque des Philos. Chimiques*, vol. 2, p. 1.

|| *Gloria Mundi, seu Tabula Paradisi*, in (a) *Museum Hermeticum*, p. 203.

¶ Michael Maier, (1) (a) *Triplus aureus*. Francofurti, 1618; (2) (a) *Visatorium hoc est de Montibus Planetarum septuor.* Oppenheim, 1618; (3) (a) *Symbola aurea mensæ*. Francofurti, 1617; (4) (a) *Secretioris naturæ secretorum scrutinium chymicum per . . . Emblemata*. Francofurti, 1637.

** Antoine Joseph Pernety, (a) *Dictionnaire Mytho-hermétique*. Paris, 1787. Idem, (a) *Les Fables Egyptiennes et Grecques dévoilées*, Paris, 1758. 2 vols.

†† (See II, next column).

‡‡ (a) Mangetus, *Bibl. chem. cur.*, II., 285, and in *Museum Hermeticum*, p. 435.

§§ Mangetus, *Bibl. chem. cur.*, II., 375.

Latin hexameters with more pretensions to elegance than usual with the prosaic alchemists was dedicated in 1514 to Pope Leo X. Leo rewarded Augurelli by presenting him with an empty wallet, remarking that one who knew so well how to make gold had need only of a purse.

The alchemists, in common with their contemporaries in other branches of literature, took pleasure in prefixing to their essays eccentric titles; Helvetius writes of "The Brief of the Golden Calf (The World's Idol) discovering the rarest Miracle in Nature;"* Glauber names one of his treatises, "The Golden Ass well managed and Midas restored to reason."†

Perhaps the height of absurdity is reached in the famous *Liber Mutus*,‡ which consists of a series of fifteen symbolic engravings purporting to disclose the whole Hermetic Philosophy. The utterly unintelligible character of much alchemical literature is occasionally acknowledged by those who otherwise accepted the prevailing popular belief in transmutation; Lenglet du Fresnoy, speaking of Raymond Lilly's *Clavicula*, says, "Lully assures us that this treatise is indispensable to the comprehension of his writings; but, after reading it, one is little wiser than before."§

There are several large collections of alchemical treatises which the curious in these matters should consult; the most extensive is Zetzner's *Theatrum Chemicum*,|| published in 1673 in six octavo volumes; this contains no less than 209 distinct treatises, notwithstanding which Lenglet du Fresnoy remarks that many excellent ones are wanting. Manger's *Bibliotheca Chemica Curiosa*,¶ published in 1702 in two folio volumes, contains 133 treatises, and the *Museum Hermeticum*** (1678) contains 21 treatises, some of which are illustrated. The most extensive English collection is Ashmole's *Theatrum Chemicum Britannicum*, published in 1652, and a noted French collection is Salmon's *Bibliothèque des Philosophes Chimiques* (1672), of which the edition by Richebourg (1741) is by far the best.††

Stimulated by avaricious hopes, the zealous alchemists laboured most industriously; and, by subjecting mixtures of all known substances to heat and to the action of acids, discovered a multitude of new bodies having more or less medical and economic value. As we have seen, their writings consist for the most part of monographs describing disconnected experiments, with no attempt at exhaustive treatment of any single topic, no classification of phenomena and no well studied arrangement of material such as characterises later handbooks. Nor can a scientific collocation be expected during the formative period of chemistry, and previous to the introduction of theories around which to group the isolated phenomena. One of the earliest attempts to treat chemical facts in a systematic manner was made by Sir George Ripley, Canon of Bridlington, who lived in the fifteenth century. In his "Compound of Alchemy," written in 1471, the whole science of hermetic chemistry is unfolded in a poem divided into twelve sections called "Gates," through which the reader is conducted to the mysteries of transmutation.‡‡

"But into chapters thys Treatis I shall devyde,
In numbre twelve, with dew recapitulatyon;
Superfluous rehearsalls I lay asyde,
Intendyng only to give trew informatyon
Both of the theoryke and practicall operatyon:
That by my wrytyin who so wyll gnyde be,
Of hys intente perfydly speed shall he.

The fyrst chapter shall be of natural Calcination;
The second of Dyssolution, secret and pholosophycall;
The third of our elementall Separation;
The fourth of Conjunction matrimonial;
The fyfth of Putrefaction then followe shall;
Of Congelation Albyficative shall be the sixt,
Then of Cybation, seaventh shall follow next.

The secret of our Sublymation the eyght shall show;
The nynt shall be of Fermentatyon;
The tenth of our Exaltation I trow.
The elevent of our mervelose Multiplycatyon,
The twelfth of Projectiō; then Recapitulatyon,
And so this treatise shall take an end,
By the help of God, as I entend.

Thus here the Tract of Alchemie doth end;
Which tract was by George Ripley, Chanon, penn'd.
It was composed, writt and signed his owne,
In anno twice seaven hundred seaventy one.
Reader, assist him, make it thy desire,
That after life he may have gentle fire! Amen.

Ripley's versification and theme remind one of Chaucer's Canon's Yeoman's Tale composed nearly one hundred years earlier.

We can only briefly allude to Paracelsus's bombastic productions,* which are concerned chiefly with medical chemistry, and to the remarkable works of George Agricola,† distinguished by profuse illustration, portraying the apparatus and operations of mining and metallurgy in the sixteenth century.

Conspicuous for accuracy of description and systematic arrangement of topics is the "Alchymia" of Andrew Libavius, published at Frankfurt in 1595.‡ Libavius, a physician and teacher in the gymnasium at Coburg, rejected the absurd doctrines of the adherents of Paracelsus, combated superstition and quackery and, excelling in observation of chemical phenomena, gained a worthy position among his compeers. In his *Alchymia* he treats of the *Encheria* or manual operations of chemistry, and of the *Chymia* or descriptions of substances, in separate books. The former he divides into two sections, one dealing with the instruments and the other with the management of fires and construction of furnaces. He describes at length a sumptuous laboratory provided not only with every requisite for chemical experimentation, but also with means of entertaining visiting guests, including such luxuries as baths, enclosed corridors for exercise in inclement weather, and a well stocked wine-cellar.

Libavius was the discoverer of stannic chloride which still bears the name "fuming liquor of Libavius;" he describes the method of preparing artificial gems by colouring glass with divers metallic oxides, and he seems to have been the first to apply the balance to the examination of mineral waters. Notwithstanding his progressive position he devotes eighty pages of his Commentary to the Philosopher's Stone, in which he was a firm believer. The second edition of his works, published in 1606, forms a folio of 800 pages. It has sometimes been called the First Text-book of Chemistry.

* Paracelsus's writings number three hundred and sixty-four on a great variety of subjects. His collected works were published at Basel in 1589 in 4to., and at Strasburg in 1605, fol.

† George Agricola, (a) *De Re Metallica*, Libri XII. Basilis, 1556.

‡ (a) Andrea Libavius, *Alchymia recognita emendata . . . sum commentario medico-phys-chymico*. Francofurti, 1606, fol.

* *Idem*, I., 196; also an (a) English Translation published by William Cooper. London, 1673.

† Bound with the preceding. Cf. also many titles in these notes.

‡ (a) Mangetus, *Bibl. chem. cur.* Vol. I., ad finem.

§ (a) Lenglet du Fresnoy, (a) *Histoire de la Philosophie Hermetique*. Paris, 1721. Vol. 3., p. 214.

¶ (a) *Theatrum chemicum precipuos selectorum auctorum tractatus de chemia*, &c. Argentorati, sumptibus H. Eberh. Zetzneri, 1659. 6 vols. 8vo. [Second Edition].

¶ (a) J. J. Mangetus, *Bibliotheca chemica curiosa*. Geneva, 1702. 2 vols., fol.

** (a) *Museum hermeticum reformatum et amplificatum*. Francofurti, 1678. Small 4to.

†† (a) J. Richebourg, *Bibliothèque des philosophes chimiques*, Paris, 1741. 3 vols., 12 mo. Cf. also, (a) Albinus's *Bibliotheca chemica contracta*, Geneva, 1654; (a) Philippum Morgenstern, *Das Buch von der goldenen Kunst*, Basel, 1613; and (a) Johann Hoppe's *Collection*. Wien, 1783.

‡‡ *Liber duodecim Portarum*, in Mangetus's *Bibl. chem. cur.*, II., 273. See also Kopp's *Geschichte der Chemie*. II., p. 9.

The "*Tyrocium Chymicum*" (1608) of Jean Beguin,* Almoner to King Louis XIII. of France, is a less pretentious work, characterised by freedom from ambiguity and prolixity as well as from hermetic superstitions; it deals chiefly with the medical applications of chemistry.

In 1660, Nicolas le Febvre, demonstrator of chemistry at the Jardin des Plantes, published a "*Traicté de la Chymie*,"† greatly superior to all preceding works of its kind. He collected the most reliable theories and experiments from all published sources and arranged them in a logical, systematic manner. The first six chapters treat of the theory of chemistry; the author admits five elementary principles: phlegm (or water), spirit (or mercury), sulphur, salt and earth, the first three being ingredients of volatile substances, and the latter those of refractory bodies. He defines metals as hard bodies generated in the bowels of the earth, capable of extension under the hammer, and of being melted by fire. He divides metals into the perfect and the imperfect, and also into male and female, the latter subdivision being based upon their behaviour with acids; gold, lead, and antimony are male metals, because soluble only in aqua regia, and the other five, silver, copper, iron tin, and mercury, are female, because soluble in unmixed acids.

In the second part the author discusses the manipulations of chemistry and recognises many nice distinctions now overlooked; for example, under the head of mechanical division he describes in detail the following operations: "limation, rasion, pulverisation, alcoholisation, incision, granulation, lamination, putrefaction, fermentation, maceration, fumigation both dry and humid, cohobation, precipitation, amalgamation, distillation, rectification, sublimation, calcination both actual and potential, vitrification, projection, lapidification, extinction, fusion, liquation, cementation, stratification, reverberation, fulmination or detonation, extraction, expression, incineration, exhalation, digestion, evaporation, desiccation, circulation, congelation, crystallisation, fixation, volatilisation, spiritualisation, corporification, mortification, and revivification."

In the experimental part Le Febvre explains the arrangement in the following language:—

"We shall begin with the meteoric bodies, rain, dew, honey, wax, and manna; we shall then describe the preparations made from animals and their secretions; next, the numerous products of the vegetable world; and lastly, the mineral kingdom with its stones, salts, marcasites, and metals;" a division still recognised.

The order in which he treats mineral chemistry is as follows:—Earths; stones, precious and otherwise; metals; semi-metals; embracing mercury, antimony, and bismuth; salts, including common salt, saltpetre, alum, sal-ammoniac, and the vitriols; and lastly, the sulphuretted minerals, arsenic, &c. Under each division he gives precise instructions for numerous experiments upon these substances and describes their medicinal value. The whole work is written in a clear style, free from affectation of mystery; it rapidly passed through five editions, and was translated into English and German.

Three years after the appearance of Le Febvre's *Traité*, his successor at the Jardin des Plantes, Christopher Glaser,‡ of Baale, published a work having the same title also marked by special excellence.

The most successful handbook of the seventeenth century was undoubtedly the "*Cours de Chymie*," by Nicolas Lemery,§ an eminent lecturer in Paris. The first edition of this work was published in 1675, and it reached the tenth edition before the close of the century; a fourteenth edition enlarged by Baron appearing as late as 1756. It

was also translated into English (1677), German (1698), Italian (1763), and Spanish. The remarkable success of this work is due to a facility for describing dry facts with remarkable simplicity and accuracy. His style is more concise than Le Febvre's, and his arrangement of material shows a progressive spirit. The limits of this address forbid an analysis of Lemery's Handbook, which, moreover, is better known than some others to which we have granted fuller treatment.

(To be continued.)

CORRESPONDENCE.

CALCIC HYPOCHLORITE.

To the Editor of the Chemical News.

SIR,—To Mr. Kingzett's question (CHEMICAL NEWS, vol. xvi., p. 120) I beg to reply as follows: In pursuance of the correspondence we had in your columns last year, I caused Dr. Schæppi to make repeated endeavours, both with English and Swiss bleach, to obtain crystallised calcium hypochlorite. Although he followed as closely as possible the rules laid down by Mr. Kingzett, he still failed in his purpose. Probably he would have succeeded in the end, but the experiments were interrupted by his leaving my laboratory for a practical situation. As I learned about that time from Mr. Watson Smith that Mr. Frost had been more successful, and as the matter did not seem to possess sufficient importance to interest another student in it (my own time being only too fully occupied elsewhere), I left it where it stands, viz., that the crystals first obtained by Mr. Kingzett from solutions of bleaching-powder have been repeatedly prepared but apparently not further examined, both by himself and others.—I am, &c.,

GEORGE LUNGE.

Zürich, September, 1882.

COMMERCIAL ANALYSES.

To the Editor of the Chemical News.

SIR,—I am a large consumer of German muriate of potash. In the great majority of cases in my experience, manufacturers of this product sell upon the basis of "Ulex's analysis"—they invariably paying his fee, and he becoming by the fact, not a neutral arbiter, but a partisan, or "seller's chemist."

As this system involves the further evil that it affords no check upon mistakes which even the most upright analyst may make, I have come to the conclusion that it will be cheaper for me in the end to pay for an analysis of my own, and to stipulate in all future purchases of the article that Dr. Tatlock, our well-known authority on the estimation of potash salts, shall act for me and settle the percentage with Dr. Ulex, the analyst for the seller, after the method that has for time immemorial been practised in the case of copper ores. I think other consumers would do well to adopt this course.—I am, &c.,

ONE.

CHEMISTRY IN GERMANY.

To the Editor of the Chemical News.

SIR,—Having returned from Germany, I observe a slight but important error in my letter (p. 112) sent you from that country. Professor Kekulé told me that the chemical course at Bonn University was chiefly organic, not "inorganic."—I am, &c.,

W. A. ROSS.

* (a) John Beguinus, *Tyrocium Chymicum*, or "*Chymicall Essayes* acquired from the Fontaine of Nature." [London], 1669, 12mo.

† (a) Nicolas Le Febvre, *Traicté de la Chymie*, Leyde, 1669. 2 vols. 12mo.

‡ Christopher Glaser, *Traité de la Chymie*, Paris, (?), 1663.

§ Nicolas Lemery, *Cours de chymie*, 1675. The editions examined were the (a) translation of the first edition, by Walter Harris, London, 1680; the (a) 12th, Paris, 1730; and the (a) 14th edition, Paris, 1756.

A NEW PROCESS
FOR INSULATING ELECTRIC WIRES.

To the Editor of the Chemical News.

SIR,—With reference to the notice under the above heading at p. 122 of your last issue, will you permit me to point out that in January last, in a letter published in the *English Mechanic* of the 20th of that month, I suggested the use of asbestos as a coating for electric wires.

As a mere electrical insulator, the greater cost of, and difficulty of working, asbestos will probably prevent its ever successfully competing with gutta-percha; but as a further coating to the gutta-percha wire (or even, perhaps, as a coating to the naked wire itself), where the wire is exposed to the risk of contact with flame, asbestos probably has a useful sphere of action.—I am, &c.,

ALFRED W. SOWARD.

5, Serjeant's Inn, E.C.,
Sept. 18th, 1882.

CHEMICAL NOTICES FROM FOREIGN
SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 8, August 21, 1882.

Appearance of Manganese on the Surface of Rocks.—M. Boussingault.—In this very discursive paper the author notes the presence of manganese in the sea and in marine vegetation. He then gives a summary of the *Challenger* expedition, referring, indeed, to the presence of manganese in submarine deposits of volcanic origin, whence he passes on to the thermal stratification of the ocean. He then considers the proportion of carbonic acid in natural waters, including those from great altitudes. This carbonic acid dissolves the iron and manganese carbonates, and on exposure to air re-deposits them as peroxides.

Expansion of the Spectral Rays of Hydrogen.—D. van Monckhoven.—The author in agreement with Mr. Norman Lockyer and in opposition to Secchi, finds that the broadening of the hydrogen rays is absolutely independent of temperature, and is due only to pressure.

Hydrodynamic Experiments: Imitation by means of Liquid and Gaseous Currents of the Stratifications of the Electric Light in Rarefied Gases and of various Forms of the Electric Spark.—C. Decharme.—The author produces an imitation of the stratifications of the electric light by carrying horizontally and quickly over a plate covered with red lead, a tube from which water flows or is blown. The current thus projected forms a straight or curved line over the powdery surface. By varying the conditions of the experiment there are found among the designs obtained forms analogous to those of the stratifications of the electric light in rarefied gases.

Remarks on M. Tommasi's Communication on the Numerical Relations between Thermic Data.—F. le Blanc.—According to M. Andrews (*Annales de Chimie et de Physique*, 1845, vol. xiv., p. 70), when a base displaces another base in its neutral combinations, the heat liberated and absorbed is always the same whatever may be the acid element. MM. Favre and Silbermann have found (*Annales de Chimie et de Physique*, xxxvii., p. 486, 1853) that the heat liberated is sensibly the same when one metal replaces another whatever may be the compound of which it forms part. These two propositions spring the one from the other, and it is merely necessary to add to the heat brought into play in the substitution of the metals the difference of their heat of oxidation, in order

to pass from the relation of Favre and Silbermann to that of Andrews. The two former physicists have shown, thirty years ago, the constant differences of the metals and the non-metals. If it has been since found that these relations do not apply to the salts formed by feeble acids, the cyanides, &c.; they nevertheless retain, in the majority of cases, a character sufficiently approximate, very interesting and very practical.

Journal für Praktische Chemie.
New Series. Vol. xxv., Nos. 9 and 10.

Preparation and Correction of Burettes.—Dr. W. Ostwald.—The author states that he has never yet met with a burette free from error, and figures an instrument for quickly effecting the necessary correction.

Sequel to a Memoir on the Cholesterines.—E. Schulze.—A supplement to a paper which appeared in this volume, p. 159. The author maintains that ordinary cholesterine and isocholesterine are definite compounds.

Crystalline Compounds of Phenol with Sulphurous Acid and with Carbonic Acid.—H. Kolbe.—An introduction to the two following papers.

A Compound of Sulphurous Anhydride and Phenol.—Lothar Meyer.—The compound was obtained by Dr. A. Hölzer (Prof. Meyer's assistant) in the winter of 1880-81, on heating dry sodium phenol in sulphurous acid, and afterwards by passing sulphurous gas into dry phenol. Owing to the instability of the compound its formula is doubtful. [A similar compound was patented by Mr. Crookes as a disinfecting agent as far back as 1872.]

An Unstable Compound of Phenol and Carbonic Acid.—A. Klepl.—Salicylic acid, para-oxy-benzoic acid, or a mixture of both, if heated for two hours to 250° to 260° in a hermetically closed tube, is entirely resolved into phenol and carbonic acid. On cooling, the contents of the tube congeal in crystals, which, if gently heated, are decomposed, yielding carbonic acid and phenol.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 6.

Hygienic Signification of Drinking-Water and on Rational Principles for its Examination.—Dr. Max Barth.—The author considers that standards permissible for different substances according to the Vienna Commission on Water Supply, the Rivers' Pollution Commission, &c., are not calculated to throw light on the suitability of a water for drinking. He examines the questions whether, and under what circumstances, can the water-supply serve as an agent for the propagation of infectious diseases, and what influence has the water-supply upon general health and on the maintenance of the maximum power of resistance against other than infectious diseases? He answers the first question in the affirmative, with especial reference to such disease-germs as are either derived from the ground or undergo there a development before they can produce disease. Such disease-germs he thinks always due to the penetration of matter from sewers and cesspools. Even abstracting from the communication of specific infectious diseases, a water must be considered unwholesome if it is either the seat of putrefaction or contains the constituents necessary to make it such. The more a water approaches the composition of a "culture-solution," the more it must be regarded as suspicious. For most waters microscopical and chemical examinations should go hand in hand.

Use of Carnallite as a Manure and for the Fixation of Ammonia.—Dr. J. Fittbogen.—Carnallite, as well as kainite, gypsum, and "waste salt," were effective in fixing the ammonia of urine. Carnallite in one instance absorbed 97.6 of the total nitrogen present in the food of the animals.

MISCELLANEOUS.

Manurial Experiments at Plan.—L. Koch.—Peruvian guano rendered soluble was tried on barley and potatoes. The smallest quantities of guano produced a visible increase in potatoes, but large doses were required to produce an effect on barley.—*Biedermann's Centralblatt*.

Adepsine.—Our attention has been drawn to a new fatty matter of mineral origin, which promises to become a formidable rival to vaseline. From a document which has reached us—written in rather questionable English—we learn that adepsine is manufactured from petroleum under the superintendence of no less eminent a chemist than Professor Fresenius. It is sent out in three forms, as yellow and white solids, and as a colourless oil of great transparency. All these preparations are free from acidity, and not susceptible of becoming oxidised or resinified by the action of the air. Hence adepsine has probably a great future in prospect for pharmaceutical and cosmetic purposes.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Rancid Butter.—Will you let me enquire the best method to treat rancid butter, and make it saleable, as much of the pure butter imported into England does not keep good more than a month or so, and when it turns rancid it has to be sold at a great loss?—W. CRIPER.

Precipitation of Copper by Electrolysis.—Will you inform me whether the acid from which the copper is precipitated by electricity at Ocker, in Germany, or at Birmingham, is sulphuric acid or not, and I would also like to know if the acid decomposed so that after the copper is precipitated it cannot be used again as a solvent for, say, carbonates of copper.—J. T.

CITY AND GUILDS OF LONDON INSTITUTE,
TECHNICAL COLLEGE, FINSBURY.

The New Building will be open in January, 1883. During the winter term, commencing Monday, October 9th, Professors ARMSTRONG and AYRTON will continue their instruction in TECHNICAL CHEMISTRY and ELECTRICAL ENGINEERING. Professor PERRY will commence a course of Lectures and Laboratory Instruction in MECHANICAL ENGINEERING, and Mr. A. F. BROWN will hold classes in DRAWING, PAINTING, Design, &c., and will commence a course of Lectures on ART FURNITURE and Fittings.—For prospectus apply at the temporary class rooms of the Institute, Cowper Street, E.C., or at the Central Office, Gresham College, E.C.

PHILIP MAGNUS, Director and Secretary.

OWENS COLLEGE, VICTORIA UNIVERSITY (MANCHESTER).—SESSION 1882-3.

1. DEPARTMENT OF ARTS AND LAW.

2. DEPARTMENT OF SCIENCE AND ENGINEERING.

The SESSION will open in these Departments on TUESDAY, October 3. Students will be admitted on and after WEDNESDAY, September 27. Candidates for admission must not be under Fourteen Years of Age, and those under Sixteen will be required to pass an Entrance Examination in English, Arithmetic, and Elementary Latin, to be held on SEPTEMBER 29.

3. DEPARTMENT OF MEDICINE AND SURGERY.

The SESSION will open on MONDAY, October 2. Students are required before entering to have passed one of the Preliminary Examinations prescribed by the General Medical Council.

4. EVENING CLASSES.

The SESSION will open on MONDAY, October 9. New Students will be admitted on WEDNESDAY, THURSDAY, and FRIDAY preceding, between half-past 6 o'clock and 9 o'clock P.M.

Several ENTRANCE EXHIBITIONS are offered for competition at the beginning of the Session in Classics, Greek Testament, Mathematics English, and History; and also a Dauntsey Medical Scholarship, value £100.

Prospectuses of the several Departments may be obtained at Mr. CORNISH'S, Piccadilly, and at other Booksellers in Manchester, and they will be forwarded from the College on application.

J. HOLME NICHOLSON, Registrar.

UNIVERSITY COLLEGE, LIVERPOOL.

The SESSION will commence on Monday, October 2nd. EVENING CLASSES on October 9th. Full Courses of Lectures for all London University Examinations in Arts or Science. Physical, Chemical, and Biological Laboratories. All Classes (except the Medical) open to both sexes on the same terms. For full details of Classes, Fees, &c., see "Calendar" (price 2s.), published by ADAM HOLDEN, 48, Church Street, Liverpool.

INSTITUTE OF CHEMICAL TECHNOLOGY
AND
ANALYTICAL LABORATORY,

5 9, and 11, PHILADELPHIA CHAMBERS, HACKINS HEY,
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The laboratories have lately been entirely re-arranged and considerably extended, and are provided with all appliances necessary for analytical investigations, special technical examinations, and students' work.

Students' fees, fifty guineas per annum.

In addition to their chemical studies, students who desire it can enter upon a course of instruction calculated to afford them knowledge useful in the erection and arrangement of manufacturing buildings and plant, and construction of apparatus. Special fees are charged for this course.

All communications should be addressed to No. 9, Hackins Hey, Liverpool.

THE MASON SCIENCE COLLEGE,
BIRMINGHAM.

The NEXT SESSION will commence on TUESDAY, the 3rd of OCTOBER, 1882.

The Calendar, containing full information as to the Classes, Fees, &c., is now published by Cornish Brothers, New Street, Birmingham. Price 2s., by post 2s. 4d.

GEO. H. MORLEY, Secretary.

UNIVERSITY COLLEGE, BRISTOL.

PROFESSOR—W. RAMSAY, Ph.D.
LECTURER—SYDNEY YOUNG, B.Sc.

Lectures on Inorganic, Organic, and Technical Chemistry will be given during the Session, beginning October 9th. The Laboratories are fitted with the most recent improvements for the study of Practical Chemistry in all its branches. There are in the evening Lectures on Inorganic and Technical Chemistry, both at reduced fees. Calendar price 6d., by post 8d.

For full particulars respecting Chemical and other Scholarships apply to

J. N. LANGLEY, LL.D., Registrar and Secretary.

WORKS BY PROFESSOR GALLOWAY.

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Recently published, price 6s.

A TREATISE ON FUEL: Scientific and Practical. With illustrations drawn to scale.

This work describes the best methods of estimating the heating power of fuel, and the technical examination and analysis of the different varieties of Coal are fully described; and among the illustrations drawn to scale are Siemens's Regenerative Gas Furnace, Pyrometer, &c., with complete descriptions.

Publishers: TRÜBNER and CO., London.

THE CHEMICAL

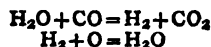
Vol. XLVI. No. 1201



THE INFLUENCE OF AQUEOUS VAPOUR ON THE EXPLOSION OF CARBONIC OXIDE AND OXYGEN.

By HAROLD B. DIXON, M.A.,
Millard Lecturer in Chemistry, Balliol and Trinity Colleges, Oxford.

Two years ago I had the honour of showing before the Chemical Section of the British Association some experiments, in which a well-dried mixture of carbonic oxide and oxygen was submitted to electric sparks without exploding.† It was further shown that the introduction of a very minute quantity of aqueous vapour into the non-explosive mixture was sufficient to cause explosive combination between the gases when the spark was passed. The hypothesis advanced to account for the observed facts was that carbonic oxide does not unite directly with oxygen at a high temperature, but only indirectly through the intervention of water-vapour present, a molecule of water being decomposed by one of carbonic oxide to form a molecule of carbonic acid and one of free hydrogen, and the latter uniting with the oxygen to re-form a molecule of water, which again undergoes the same cycle of changes, till all the oxygen is transferred to the carbonic oxide :—



For such a series of reactions a comparatively few molecules of water would suffice, and the change produced by their alternate reduction and oxidation would come under the old term of "catalytic action," inasmuch as the few water molecules present at the beginning are found in the same state at the completion of the reaction.

The truth of this hypothesis has since been confirmed by experiments I have made on the incomplete combustion of mixtures of carbonic oxide and hydrogen, and on the velocity of explosion of carbonic oxide and oxygen with varying proportions of aqueous vapour. I therefore thought a description of the more convenient methods lately devised as lecture experiments for showing the influence of water on the combustion of carbonic oxide would not be uninteresting to the Section.

A glass tube from 18 inches to 2 feet long, closed at one end, and provided with platinum wires, is bent near its open end so that the shorter arm makes an angle of about 60° with the longer arm. The tube, held by a clamp, is heated in a Bunsen flame, and is then filled with mercury heated to about 130° C. The mixture of gases is then made to displace a portion of the mercury by forcing it through a fine tube, which is connected by a steel cap to the eudiometer of McLeod's gas apparatus, and passes down through the mercury in the shorter arm of the experimental tube. When a sufficient quantity of the gaseous mixture has been collected in the longer arm, some dry phosphoric oxide is introduced in the following way :—A small glass tube is heated, packed with the dry powder, and pushed down into the shorter arm of the experimental tube. With a hot glass rod the phosphoric oxide is pushed out at the bottom of the small tube, and passes up into the gaseous mixture in the longer arm. After standing for a few hours in contact with the phosphoric oxide, the gases may be submitted to strong sparks from a Leyden jar without igniting. Care must be taken that none of the oxide comes in contact with the platinum

wires, for if any sticks to the wires it becomes heated by the passage of the sparks, and gives off enough water to determine the explosion. In this way I have prepared several specimens of a non-explosive mixture of carbonic oxide and oxygen in the proper proportions to form carbonic acid. Some of these tubes have been submitted without explosion to sparks from a large Leyden jar, to a continuous succession of sparks from a Holtz machine, and to the discharge of a Ruhmkorff's coil, that heated the platinum wires between which it passed to bright redness. Other tubes which withstood the passage of the sparks from a Leyden jar, when submitted to the discharge of the coil, exploded after a few seconds when the platinum wires became red-hot. This I think may probably be attributed to hydrogen, occluded by the platinum, being given off on heating, and forming steam with the oxygen present.

For an easy and striking lecture experiment, I employ a tube open at both ends and bent like a W. The two open arms are short and the platinum wires are fixed at the highest bend. The tube is filled with hot mercury—one of the ends being closed by a caoutchouc stopper for the purpose—and a dry mixture of 5 volumes of air and 2 volumes of carbonic oxide is introduced into the bent tube over the mercury. A little phosphoric oxide is passed up one arm. After a few minutes the gases may be submitted to the spark without exploding. A little water may then be introduced through a pipette into the other arm, and if the spark is passed directly the gases ignite in the wet and not in the dry arm of the tube.

The admixture of the inert nitrogen renders a larger quantity of aqueous vapour necessary for the explosion than when only carbonic oxide and oxygen in proper proportion are present.

THE VELOCITY OF EXPLOSION OF A MIXTURE OF CARBONIC OXIDE AND OXYGEN WITH VARYING QUANTITIES OF AQUEOUS VAPOUR.*

By HAROLD B. DIXON M.A.

I HAVE endeavoured to compare the velocities of explosion of mixtures of carbonic oxide and oxygen with varying quantities of aqueous vapour by observing the pressure registered in a mercurial gauge attached to the eudiometer in which the gases were fired. In each experiment the same mass of carbonic oxide and oxygen was exploded at nearly constant temperature and volume. The gauge (of 1 m.m. bore) was J-shaped, and contained air in the closed limb. An index, similar to those used in Six's thermometer, was carried up and left at the highest position reached by the mercury. Near the bend of the gauge two bulbs were blown in the tube, as reservoirs, enabling the mercury to be lowered in the eudiometer without permitting the air to escape from the closed limb of the gauge.

Since the total quantity of heat evolved in each explosion was the same, and the cooling surface was the same in each experiment, a quicker explosion would bring the column of gases to a higher average temperature than a slower explosion, and would consequently cause a sharper push on the mercury column. If a sufficiently sensitive gauge were attached to the eudiometer its readings would give comparative indications of the rate of explosion of the carbonic oxide and oxygen. The gauge employed was found to be not very sensitive, but the difference between its readings, (1) with the slow combustion of the nearly dry gases, and (2) with the rapid explosion of the saturated gases, was well marked.

In two experiments a trace only of aqueous vapour was

* Read before the British Association, Southampton Meeting, Section B, 1882.
† "Report of British Association," 1880, p. 503.

* Read before the British Association, Southampton Meeting, Section B, 1882.

present. The eudiometer was dried at 80° C. by drawing through it for half-an-hour air which had passed through two long sulphuric acid drying tubes and a small tube containing phosphoric oxide. It was found that by this method of drying, just sufficient aqueous vapour remained in the tube to enable the combustion to take place slowly when sparks from a Ruhmkorff's coil were passed through the gases. In the first experiment several sparks were passed before the gases took fire. In both experiments the flame took about two seconds in passing down the length of 500 m.m. occupied by the gases in the eudiometer. In three other experiments measured quantities of aqueous vapour were added, the vapour being kept below the saturation-point; in the last two experiments the space was saturated with aqueous vapour, and the sides of the eudiometer were wet.

The following table gives the quantities of aqueous vapour in each experiment, the readings of the pressure gauge, and the pressures corresponding to those readings:—

TABLE.
Explosion of Carbonic Oxide and Oxygen with Varying Quantities of Aqueous Vapour.

	Tension of Carbonic Oxide and Oxygen.	Tension of Aqueous Vapour.	Reading of Pressure- gauge before Explosion.	Reading of Pressure- gauge after Explosion.	Pressure Registered in Gauge.	Temper- ature of Gases.	Length of Column.
	M.m.	M.m.			M.m.		M.m.
1.	200	trace	229	236	562	33° C.	500
2.	"	trace	"	236.2	563	33.2	500
3.	"	8.7	"	249.2	620	33	505
4.	"	9.4	"	249.6	622	33.5	505
5.	"	25	"	249.4	621	34	514
6.	"	38	"	252.6	638	33.3	524
7.	"	40	"	252.6	638	34	525

Before each explosion the mercury in the gauge was brought to the mark 229 on the scale, which indicated a pressure of 533 m.m. of mercury on the air in the closed limb.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Indium.—Indium ferrocyanide being relatively very soluble (especially at 60° to 70°) in a hydrochloric liquid containing from $\frac{1}{4}$ to $\frac{1}{2}$ of the concentrated acid potassium ferrocyanide may be used for extracting moderate quantities of indium mixed with much gallium. Yet gallium ferrocyanide retains sensible traces of indium, and the operation needs to be repeated if we wish to obtain an exact separation. This inconvenience, and that of introducing iron into the analysis, render the process somewhat long and difficult. It is only to be recommended when we wish to separate along with a little indium other metals, such as aluminium and chromium.

Of all the methods tried the following is the only one which effects a prompt and accurate separation. The solution, suitably concentrated, is treated with a slight excess of boiling potassa. The boiling is kept up for some minutes, for in the cold indium oxide is not immediately thrown down by potassa. The precipitate retains merely very slight traces of gallium, which are entirely eliminated by one, or at most two, repetitions of the same treatment. The potassic solutions contain merely slight traces of indium capable of being neglected in weight if the masses of gallium and indium are small, and consequently the volume of the alkaline liquids is moderate. To extract these traces of indium the solution is supersaturated with a very slight excess of hydrochloric acid, and the gallium and indium are precipitated together by slowly boiling the liquid after supersaturation with ammonia, or better still by means of cupric hydrate. The gallium and indium

chlorides are transformed into slightly acid sulphates; a quantity of ammonium sulphate is added, slightly larger than what is necessary to transform all the gallium sulphate into alum, and the liquid is then concentrated to a very small volume. After cooling, whether crystals of alum are already formed or not, the solution is mixed with four to five times its volume of alcohol at 70 per cent. The agitation causes the deposit of gallium-ammonium alum in a crystalline powder which is washed once or twice with alcohol at 70 per cent. The alum is then taken up in a little hot water containing a trace of sulphuric acid and the operation is repeated several times. By far the larger quantity of the gallium is in this manner transformed into ammoniacal alum free from indium. The alcoholic solutions containing a small quantity of indium and gallium are concentrated down to a small bulk. The oxides are thrown down by boiling with ammonia, or by means of cupric hydrate; they are dissolved in hydrochloric acid, and are then treated with boiling potassa. We obtain thus a small supplementary quantity of indium free from gallium. As very little potassa suffices the slight traces of indium in the alkaline solution are absolutely unimportant, though the last residue of gallium may be separated as alum if its quantity is noteworthy. Generally the traces of indium carried by the potassa along with the gallium are entirely eliminated after four alcoholic crystallisations of the gallium-ammonium alum. With gallium containing 4 per cent of indium seven or eight re-crystallisations are necessary. These operations are performed very rapidly and easily with the salt derived from less than 0.05 grm. of gallium.

Separation from Cadmium.—This separation is effected in an approximate manner only by means of sulphuretted hydrogen. The difficulty is that in presence of a decided excess of hydrochloric acid the cadmium is not entirely precipitated, whilst if the solution is scarcely acid a portion of the gallium remains in the cadmium sulphide. Nevertheless, good results may be attained by a succession of operations, each of which yields a decreasing quantity of cadmium sulphide free from gallium. For this purpose a decidedly acid solution is treated with sulphuretted hydrogen, the precipitate is re-dissolved with hydrochloric acid, diluted with water, and again treated with sulphuretted hydrogen. This reaction, if repeated once or twice, enables us soon to collect the greater part of the cadmium as a sulphide free from gallium. The liquids which hold in solution all the gallium along with a little cadmium are concentrated to expel the large excess of acid, diluted with water, and saturated with sulphuretted hydrogen. The new deposit of cadmium sulphide obtained is dissolved and re-precipitated once or twice to free it from gallium. The repetition of this treatment frees the gallium chloride from every sensible trace of cadmium.

An excess of boiling potassa precipitates cadmium oxide and dissolves gallium oxide, of which a small quantity remains in the cadmium oxide. It is therefore re-dissolved in hydrochloric acid and separated again by means of potassa. When the cadmium is in a somewhat large proportion four or five treatments are needful to extract all the gallium. The alkaline liquids contain merely feeble traces of cadmium; to separate these the liquid is supersaturated with a very slight excess of hydrochloric acid, and the gallium is removed by means of cupric hydrate. The filtered solution is mixed with a little ammonium acetate and saturated with sulphuretted hydrogen, which precipitates copper and cadmium sulphides. These are taken up in aqua regia, evaporated with an excess of hydrochloric acid to destroy the nitric acid, and this very acid solution is then treated with sulphuretted hydrogen. The copper is thus eliminated, and we have merely to concentrate in order to obtain cadmium chloride.

The four following procedures are more expeditious:—

1. A prolonged boiling after supersaturation with ammonia precipitates gallium and leaves cadmium dissolved, but the original liquid should be very acid in order

to form a sufficient quantity of ammonium chloride. The gallium oxide thus obtained retains very slight traces of cadmium, which are eliminated by a second similar treatment.

2. The separation can be effected well with potassium ferrocyanide, provided that the liquid contains about one-third of its volume of concentrated hydrochloric acid, which holds the cadmium ferrocyanide in solution.

3. Cupric hydrate, with the aid of heat, precipitates gallium containing scarcely a trace of cadmium, which a second operation entirely removes. This is an excellent process.

4. If it is required to remove iron at the same time as cadmium the slightly acid liquid is reduced in heat by metallic copper, and is then mixed with a slight excess of cuprous oxide. The gallium oxide collected contains traces of cadmium which disappear on a repetition of the same treatment. The reactions of cupric hydrate and of metallic copper with cuprous oxide are the most to be recommended of all which the author has studied.—*Comptes Rendus*.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING AUGUST 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE
LOCAL GOVERNMENT BOARD.

September 1st, 1882.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the month of August, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 182 samples, one was recorded as slightly turbid, and one as very slightly turbid. The remaining 180 samples were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from August 1st to August 31st inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, one was recorded as "slightly turbid," and one as "very slightly turbid," the remaining 24 samples being found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole were found to be well filtered, clear, and bright.

With regard to the general state of the water in respect of its freedom from turbidity, we would draw special attention to the circumstance, that out of the 1074 samples of water examined by us during the six months ending August 31st, and despite the frequent storms of July and August, twenty samples only, or less than 2 per cent, were recorded as "very slightly turbid," and seven samples only, or less than $\frac{1}{2}$ of a cent., as "slightly turbid."

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

In respect of colour, aëration, and freedom from excess of organic matter, the excellent condition of the water, as noted in our previous reports, has been fully maintained.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

CHEMICAL LITERATURE.

AN ADDRESS DELIVERED BEFORE THE AMERICAN
ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,
AT MONTREAL, AUGUST 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

(Continued from p. 148).

PASSING over a period of fifty years, the next complete compendium of chemical knowledge which we notice is the "Elementa Chæmiæ" of Hermann Boerhaave, the celebrated professor of botany, chemistry, and medicine in the University of Leyden. Boerhaave's great erudition, purity of style, and brilliant eloquence attracted students in great numbers; such was the popularity of his lectures that "certain booksellers who aimed at lucre by the most scandalous means," published them in 1724, without his authority or consent; this "surreptitious edition" contained, as Boerhaave himself complains, such "false, ridiculous, and absurd things in every page," that he was compelled to publish his lectures in an accurate and complete form. Both editions were translated into English by Dr. Peter Shaw, and the authorised work passed through many editions in Latin, French, and German.† Instead of attempting to give an analysis of two quarto volumes, we will quote Boerhaave's own account of his plan.

"My design," he says, is to initiate students in the knowledge of chemistry and to do this in the most effectual manner, I shall give a clear methodical explication of all that is necessary for understanding the best authors, and for performing the chief operations in this experimental art." After acknowledging the difficulty of a systematic treatment of "a science which has been cultivated rather by experiments at random than upon any regular principles, and by persons usually destitute of all . . . knowledge in the liberal arts;" he claims that "these obstacles may be surmounted by making a collection of the several effects, which the art has actually pro-

(Works marked (a) are in the private library of the author.)

* (a) Herrman Boerhaave, "A New Method of Chemistry including the Theory and Practice of that Art." Translated by Peter Shaw and E. Chambers. London, 1724.

† (b) Herrman Boerhaave, "A New Method of Chemistry including the History, Theory, and Practice of that Art." Translated by Peter Shaw. London, 1773. [Third Edition.]

duced, justly deducing general rules therefrom, and duly digesting the whole." He then explains the division of his work into three parts.

"The first will rehearse the origin, progress, cultivation, and fortune of chemistry . . . ; the second part will deliver certain theorems or principles of chemistry; the third will exhibit the actual operations of chemistry, whereby bodies are changed agreeably to the rules of the art and to the end proposed therein." Boerhaave's sketch of the history of chemistry begins with the earliest times, but seems to have been left incomplete; it is rendered useful by classified lists of chemical writings and numerous references.

In his treatment of the theory he departs somewhat from his plan and introduces material which really belongs to the third or practical part. Boerhaave introduces sections on the use of chemistry in natural philosophy, in medicine, and in the mechanical arts; gives an exhaustive account of the wonderful nature of fire, and experiments in heat, together with ingenious speculations concerning the heat of celestial bodies; he describes the various forms of chemical apparatus and the preparation of curious and useful substances from the vegetable, animal, and mineral kingdoms. Boerhaave exhibited the spirit of a true philosopher, and produced a work of extraordinary merit. He was quite free from the follies of alchemy, though he cautiously remarks that "we should always remember the limits of nature are by no means to be defined by us, things are taken for impossible which are only unknown by the ignorant," and "many things in chemistry are apparently more incredible than that lead should lose its natural form and be converted into gold."

Contemporary with the systematic compilations of Libavius, Le Febvre, Boerhaave, and others, were published hosts of independent works setting forth the results of prodigious labour in the chemical laboratory; many of these are filled with descriptions of experiments made at haphazard, with no definite object in view, and having no necessary connection with each other.

Glauber's† voluminous writings, published in 1658, may be taken as an example of this class; in his works, amid controversies with Galenical physicians and curious apologies resulting therefrom, amid descriptions of alchemical mysteries and receipts for a universal panacea, amid extravagant praises of the "sal mirabile" (Glauber's salt), and curious narratives of personal history, we find many novel chemical facts having a medical or an industrial value. The whole is clothed in a very crude style with an affectation of secrecy and under capricious captions.

On the other hand, some of these treatises show signs of genius, especially in attempts to establish theories in explanation of the familiar yet astonishing phenomena; thus Van Helmont, whose contributions to medical chemistry we pass by, invented the word *gas* to aid in discriminating aëriiform bodies;‡ and Rey, in his "Essays on the increase in weight of tin and lead when calcined;"§ demonstrated the weight of the air thirty years before the masterly researches of Boyle.

To attempt in this rapid review to do justice to the philosophical writings of the Hon. Robert Boyle is a hopeless undertaking. From his first publication, in 1660, "New experiments, physico-mechanical, touching the spring of the air and its effects," to his posthumous treatise "Medicinal Experiments," published in 1692, his works teem with ingenious experiments described with great candour and fidelity, and from which conclusions are drawn with cautious reserve and philosophical soundness, as admirable as his rare modesty.

In his "Sceptical Chymist" (London, 1661), Boyle raises doubts as to the elementary nature of earth, air,

fire, and water, as well as of the alchemical principles, sulphur, salt, and mercury, and claims that the first elements of bodies are atoms of different shapes and sizes, the union of which forms what are vulgarly called elements; he argues that their number should not be confined to three nor four, but that probably a large number of primary constituents would eventually be separated or isolated as such. He also first clearly recognises the distinction between mixture and chemical combination.

The rejection of Boyle's prophetic hypothesis by his contemporaries much retarded the progress of the science. "More, however, than for his views on the nature of the elements, science is indebted to Boyle for his clear statement of the value of scientific investigations for its own sake, altogether independent of any application for the purposes either of the alchemist or of the physician. . . . Boyle was in fact the first true scientific chemist, and with him we may date the commencement of a new era for our science when the highest aim of chemical research was acknowledged to be the simple advancement of natural knowledge." (Roscoe).

Boyle's voluminous writings were collected by Birch in five folio volumes and published in 1744. His diffuse style of composition, with frequent long digressions, renders a perusal of his writings wearisome, and led to an edition by Dr. Shaw, in which his works are "abridged, methodised, and disposed under general heads," forming three quarto volumes bearing the date 1725.* Many of Boyle's papers were published in the *Philosophical Transactions*.

The literature pertaining to the theory of phlogiston belongs almost wholly to the eighteenth century. It is true that Becher's *Physica Subterranea* was published in 1659,† but the theory of a combustible principle existing in all metals remained dormant until Becher's admirer, George Ernest Stahl, published an edition of the *Physica Subterranea* in 1702; to this he prefixed a long preface elaborating those doctrines which exerted such immense influence on both the theoretical and practical science, for more than a century. The writings of Becher and Stahl are notorious for their barbarous mixture of poor Latin and German, for which indeed both authors apologise;‡

In Mayow's *Treatise on the nitro-aërial spirit*,§ we find records of admirable experiments in pneumatic chemistry supported by accurate reasoning and almost prophetic insight of later theories of combustion, but his early death prevented the continued support of his views, and Mayow's treatise was soon forgotten by the prejudiced followers of Stahl.

In the year 1683 a noteworthy event occurred in the chemical world, the opening of public laboratories of instruction. Chairs of chemistry had long existed in institutions of learning, the first being filled nearly eighty years before by Johann Hartmann, and the honour belonging to the University of Marburg. Practical instruction had been secured also in the private laboratories of the wealthy, thus Homberg and Friedrich Hofmann worked in Boyle's establishment,|| but the first public laboratory for instruction was opened at Altdorf, Bavaria, under the direction of Prof. J. M. Hofmann. A survey of the status of chemical knowledge at that date offers a tempting digression, but the length of this address forbids.

The second public laboratory was opened in the same year (1683) at Stockholm, under the patronage of Karl XI. of Sweden, and under the guidance of Urban Hiärne. Both institutions issued publications bearing the general title *Acta*,¶ which may be regarded as forerunners of the

* (a) The Philosophical Works of . . . Robert Boyle abridged . . . by Peter Shaw. London, 1725. 3 vols. 4to.

† (a) J. J. Becher, *Chymisches Laboratorium oder Unterirdische Naturkundigung*. Frankfurt, 1690.

‡ Kopp's *Geschichte*, I., 180 and 192.

§ *Tractatus quinque medico physici quorum primus agit de nitro et spiritu nitro-aereo* . . . Oxonii, 1674.

|| Kopp's *Geschichte*, II., 19.

¶ (a) *Acta laboratorii Altdorfensi*. Altdorf, 1719. Also: *Laboratorium novum chemicum*, &c., 1683. *Actuum chemicarum Helosium*.

* *Idem*, vol. I., p. 204.

† (a) The works of John Rudolph Glauber, containing great variety of choice secrets in medicine and alchemy . . . Translated into English by Christopher Packe. London, 1649, fol.

‡ *Ortus medicinae, vel opera et opuscula omnia*, 1648.

§ Jean Rey, *Essais sur la recherche de la cause, pour laquelle l'Estain et le Plomb augmentent de poids quand on les calcine*, Bazas, 1630.

"Contributions from the Laboratory of — University," now so common in periodical literature.

Lexicons and dictionaries have been a feature of chemical literature from the earliest times; we have already alluded to the vocabularies of the sacred art found among the Greek MSS. of the Paris National Library, and referred to the tenth and eleventh centuries. These, however, seem to have been compiled for the purpose of misleading the novice in alchemical mysteries, and as Hoefer justly remarks, themselves need commentaries to become intelligible.

The universal employment of symbolic characters, to represent both chemical substances and operations, rendered alchemical literature difficult of perusal and early led to the publication of keys and vocabularies explaining them. Such keys occur in the manuscripts just mentioned, in Eichenreuter's "Universal Panacea for Men and Metals,"* which purports to have been written in or before the fourteenth century, and in the works of Oswald Crollius,† Kircher,‡ Le Febvre, Lemery, and many other authors of the seventeenth century: these, however, are not properly dictionaries.

Dr. Martin Ruland, court physician to Rudolph II., published a "Lexicon alchemiæ" in 1612, and William Johnson§ a "Lexicon chymicum" in 1657, but the first really satisfactory treatment of chemistry in monographs alphabetically arranged was by Macquer,|| whose "Dictionnaire de Chymie," published in 1766, had great success, passing through several editions, and being translated into the German, English, Italian, Spanish, Danish, and Russian languages.¶ Macquer found many followers, among whom may be mentioned Nicholson (1795), Cadet (1803), and well known authors whose works are indispensable to all students of the science.

Prof. Wm. Ripley Nichols, of Boston, late chairman of this Section, in a recent private communication, has expressed the need of yet another dictionary, one of chemical synonyms. He calls attention to the large number of names by which certain chemical substances have been known at different epochs and in different professions, and to the utility of a dictionary explaining their synonymy. Professor Nichols suggests "restricting the list to terms found in the literature of the preceding hundred years, but including such alchemical names as have peculiar historic interest and such as have persisted more or less in commerce and pharmacy." He also suggests that the work should include English, French, and German names, except when they are simply literal renderings of the same term, and names of those minerals which are of simple composition like halite, witherite, fluorite, &c., under their appropriate heading. In an example of the proposed method of treatment he gives a long list of names for ferric oxide under the several heads: alchemical, chemical, mineralogical, pharmaceutical, commercial, and popular.

The idea is certainly excellent, and we mention it publicly in the hope that Professor Nichols may be incited to compile such a work. We are not aware of the existence of any modern chemical synonymicon, not having seen Berta's Dictionary of chemical terms,** published at Padua in 1842; perhaps the nearest approach to the ideal work of Professor Nichols is Sommerhoff's Lexicon pharmaceutico-chymicum,†† published in 1701, a folio of 400 pages.

About the middle of the seventeenth century the dissemination of the views of Lord Bacon, as expressed in

* (a) Basilii Valentinus Chymische Schriften in drei Theile. Leipzig, 1769, p. 1050.

† (a) Tractat von den Signaturen, p. 58, in Crollius's Basilica Chymica. Frankfurt, 1647.

‡ (a) Athanasius Kircher, Mundus subterraneus in XII. libros digestus. Amstelodami, 1669, fol. Part II., p. 322.

§ In Mangetus's Bibl. chem. curiosa, i., 257.

|| P. Jos. Macquer, Dictionnaire de chymie. Paris, 1766.

¶ Kopp's Geschichte, i., 224.

** Antonio Berta, Saggio di un dizionario dei termini chimici. Padova, 1842. 8vo. 32 pp.

†† (a) Joh. C. Sommerhoff, Lexicon pharmaceutico-chymicum latino-germanicum. . . . Norimberg, 1701. 8m. fol.

his *Novum Organon*, gave a great impulse to scientific investigations, and the "splendid fiction of the new Atlantis" was practically realised in the foundation of the "Royal Society for Improving Natural Knowledge." The learned men, who in 1645 met in London, and there disturbed by unhappy dissensions of civil war withdrew to Oxford to report and discuss philosophical experiments, laid the foundations of an edifice destined to rise higher, endure longer, and to shelter a nobler offspring than the most sanguine could have foreseen. The organisation was granted a charter by King Charles II. in 1662, and three years later began the publication of the "*Philosophical Transactions*," giving some account of the present undertakings, studies, and labours of the ingenious in many considerable parts of the world." In the following year the French Academy of Sciences began their *Mémoires*. Thus arose the element of periodicity in scientific literature, one which rapidly increased in importance.

The year 1665 also witnessed the birth of the parent of that large class of periodicals not issued by societies, but published by private parties either individually or coöperatively. The first number of the "Journal des Sçavans" appeared January 5, 1665, and for one hundred and thirty years was the most prominent literary and scientific journal of Europe. At that early date the periodicals partook of a literary nature rather than of the scientific, but gradually these two elements became distinct, and the lines became more and more closely drawn until every branch of pure and applied science supported a serial especially devoted to its progress. Among the earliest periodicals devoted to chemistry and its associate physics may be mentioned the "Journal de Physique et de chimie," edited by the Abbé Rozier, de la Méthérie, and others, begun in 1770, and continued through ninety-five volumes to 1822; the "Chemisches Journal" of Lorenz Crell, 1778-86, which was followed by the "Chemische Annalen," by the same editor, extending until 1803. The "Annales de Chimie et de Physique," begun in 1789, enjoys the honour of being the oldest surviving serial of this class.*

Of the foundation of societies exclusively devoted to chemistry in France, England, Germany, and America, and of their periodical publications, we can make mere mention. The existence of a "Columbian Chemical Society" in Philadelphia, as early as 1811, deserves passing notice. Two volumes of its *Memoirs* were published containing articles by Drs. Mitchell, Cutbush, Manners, Bache, and others.

Of chemical bibliography and works relating exclusively to the history of the science, we have elsewhere† given a critical résumé.

(To be continued).

Black Phosphorus.—P. Thenard.—The author refers to the customary view that black phosphorus is merely a mixture of the ordinary phosphorus with traces of a metallic phosphide, and contends that this explanation is not in all cases admissible. A specimen of black or rather dark grey phosphorus, which the author submitted to the Academy, became white if melted and remained white if suddenly cooled, but if allowed to enter into a state of superfusion it became again black on contact with either white or black phosphorus. A portion of the black specimen being dissolved in carbon disulphide there remained undissolved merely a trace of a very pale yellow matter which seemed to be amorphous phosphorus.—*Comptes Rendus*.

* The *Journal de chimie et de physique* of Van Mons begun in 1801, and *The Chemist*, edited by M. Mongredien, in 1822, were short-lived. This is true also of Richter's *Neuere Gegenstände in der Chemie*. 11 nos., 1791-1802.

† H. C. Bolton, "Outlines of a Bibliography of the History of Chemistry," *Annals N. Y. Lyc. Nat. Hist.* Vol. 10, p. 354 (1873).

NOTICES OF BOOKS.

The Concepts and Theories of Modern Physics. By J. B. STALLO. International Scientific Series. Vol. xlii.

IN this volume some of the fundamental theories of modern physics are subjected to a searching analysis, with the object of showing how far these are legitimate, and how far they satisfy the requirements of logic and the conditions of valid hypothesis.

The author has precisely the qualifications for instituting such an enquiry, in being well versed in both logic and physical science, and in having a wide acquaintance with the literature of both; and in his independent habit of thought, which prevents his judgment being enslaved by any school of philosophy.

The book abounds in admirable and interesting discussions of fundamental principles of physical science, of which, in the space of a short review, it is useless to attempt to give an adequate account, although some slight idea may be given of the nature of the author's method of dealing with his subject by selecting one or two examples in illustration. It may safely be said that by students of physics and chemistry this book will be found full of interest, not only for the author's discussions, but also for the copious foot-note references to numerous authorities in philosophy and science, which last are indeed a most important and characteristic feature of the book.

It will be desirable to give some slight idea of the scope of the work by stating the scope of its successive chapters, although space will not allow of detailed criticism of the views which the author seeks to establish, or of those which he disputes.

In Chapter I. he contests the general proposition that all physical action is "mechanical" (p. 23).

In Chapter II. he states the first principles of the mechanical theory of the universe to be (p. 28) (1) that the ultimates of scientific analysis are mass and motion; (2) that these two ultimates are disparate, so that mass is indifferent to motion,—that motion may be transferred from one mass to another; (3) that both mass and motion are constant. To these principles he adds the assumption generally made by physicists and chemists of the molecular and atomic constitution of bodies; which assumption leads (according to the author) to four cardinal propositions of the atomic-mechanical theory, each of which he shows, in Chapters III., IV., V., to be denied by the sciences of chemistry, physics, and astronomy; while in Chapter VI., on the "Conservation of Energy," his purpose is, as he says, to show that the history of the evolution of the scientific concepts embraced in this doctrine is (p. 82) the history of a progressive abandonment of the mechanical proposition that all potential energy is in reality kinetic.

Chapter VII. is devoted to the theory of the atomic constitution of matter; to the arguments adduced in support of it from the "indestructibility of matter," and its supposed impenetrability, and the explanations of both by the theory; from Dalton's laws of combining proportions in chemistry; and from the success of the hypothesis of an atomically constituted light-bearing medium in explaining and predicting phenomena. The author comes to the conclusion that *the atomic theory is of doubtful value, even as a working hypothesis.*

In Chapter VIII. a discussion of the kinetic theory of gases is preceded by a discussion of the views held by eminent modern authorities on logic as to the use and abuse of hypothesis; and the author has the courage—some will say the audacity—to declare as his conclusion that the kinetic hypothesis (p. 1.6) has none of the characteristics of a legitimate physical theory.

Having thus dealt with what he calls the mechanical theory of the phenomena of nature and with some applications of it, the author institutes an inquiry (in Chapter IX.) into the question of the origin of this theory

and into its attitude towards the laws of thought and the forms and conditions of its evolution (p. 129). He enumerates in this chapter four cardinal metaphysical errors. To show that the mechanical theory is vitiated by these errors is the object of the author in Chapters X., XI., and XII.

Chapters XIII. and XIV. are devoted to the discussion of transcendental geometry; Chapter XV. to the nebular hypothesis and other cosmological and cosmogenetic speculations; while his general conclusions are summed up in Chapter XVI.

The objections of the author to the "mechanical theory" depend largely on his views with regard to matter, mass, motion, force, space, time, as fundamental concepts of modern physics; some of the most important statements of the author with reference to these will now be given as nearly in his own words as the necessary brevity of this review will allow.

Matter (pp. 149, 150) is an ideal concept, formed by putting aside all the physical attributes of bodies except the one which characterises all bodies as physical objects; this one is known under the two aspects of *mass* and *force*, or of *mass* and *motion*; neither mass, force (p. 162), nor motion is an object of sensible experience, nor can mass be thought of by itself; but the two, mass and force, or mass and motion, are the two inseparable attributes of the concept "matter."

Mass—or *inertia*—has no existence apart from force or motion, and neither force nor motion apart from mass (p. 161), and neither mass nor force (or motion) can be measured (pp. 88, 205) except in terms of the other.

Masses are measured only (p. 88) by the action of forces, and the persistent effect of this action is the simple and accurate expression of what is called the "indestructibility of matter" (see also p. 149).

Bodies exist (p. 163) solely in virtue of their relations; their reality lies in their mutual action. Inert matter (or dead matter) is as unknown to experience as it is inconceivable in thought. A body cannot move itself, for the same reason that it cannot exist in and by itself. The very presence of a body in space and time, as well as its motion, implies interaction with other bodies, and therefore *actio in distans* (see also pp. 65, 145).

Force (p. 167) is not an individual thing or entity . . . it is purely an incident to the conception of the interdependence of moving masses; force is the (cause, or) condition, or group of conditions, upon which change of motion depends, and these conditions are always corresponding motions or changes of motion of the bodies outside of the body in question which are its dynamical correlates. Otherwise expressed, force is a mere inference from the motion itself under the universal conditions of reality . . . ; it has no other existence. Force is (p. 168) a purely conceptual term, and not a distinct reality; force and inertia are conceptual integrants of matter, and neither is in any proper sense a fact (p. 161).

[Modern writers on Physics use the word "force" exclusively in the sense of *vis impressa*; Newton used it in the two senses of *vis inertia* and *vis impressa*. In the celebrated scholium to the laws of motion, *vis* is used to include both applications of it. With the result that by the words "*ex ejus vi et velocitate conjunctim*," Newton includes under the third law both the principle of action and reaction, and the principle which foreshadowed the doctrine of the Conservation of Energy.]

When the author says that the concept "matter" involves the inseparable attributes, mass and force, or mass and motion, this statement includes the two aspects of matter involving, the one, mass and configuration, and the other, mass and velocity; and therefore the two forms of energy—potential and kinetic.

The author objects (p. 169) to the statement when a body is said to be endowed with a definite quantity of force, as implying the independent reality of force, and as ignoring the fact that the conception of force depends upon the relation between two terms at least; also to the

assumption that an invariable measure of energy is inherent in every particular body or atom; yet, on page 304, he says that each element or compound embodies a distinct and invariable amount of energy, as well as a distinct and invariable quantity of matter (*i.e.*, mass). It is clear that his objection to the statement with reference to such a misuse of the conception of force, as he quotes on page 169, is backed by arguments which do not apply in the case of energy, and that we may therefore look on his statement on page 304 as his opinion in the matter of energy, rather than the statement on page 169.

It will be interesting to see how far the author's account of matter, inertia, force agrees with corresponding statements of Newton in his "Definitions," especially as the author is apparently of opinion that he is in these respects much at variance with Newton.

On page 39, the author, alluding to the definition of impressed force (Def. 4) given by Newton and to Newton's comments on it, seems to infer that Newton considers mass and motion as disparate, as if mass were indifferent to motion so as to remain the same whether in motion or at rest, and as if motion were transferable from one mass to another. Newton (Def. 1) deduces the "quantity of matter" or mass of a body from the results of accurate experiments with pendulums, *i.e.*, he measures masses (relatively to one another) by reference to force (of gravity) or motion; and the measure of the mass of a body once determined is a constant for that body, in all interactions of it with other bodies, and remains the same whether the body be in motion or at rest. So far, there can be no difference of opinion—notwithstanding the fact that mass cannot be represented in thought (p. 14) apart from all idea of force or motion. The statement of Newton is quoted on this page, that "Impressed force consists in action alone and does not abide in the body after action" (Def. 4). The author objects here not to the accuracy of this statement, but to the point of view, which seems to him to suggest a separation of the "conceptual integrants of matter," mass and motion, as if these were disparate, rather than the fusion of the two, which is more consonant with the true relations of these concepts (p. 150), and which fusion is satisfactorily effected by the scientific concepts, potential and kinetic energies.

But the author seems a little too ready to leap to the conclusion that Newton's statements are at variance with a correct appreciation of a true logical view of the terms mass, force, &c. From the author's own standpoint, change of motion (p. 167) of a body depends upon motion or change of motion of bodies (its dynamical correlates) external to the body, and therefore consists only in the action of these bodies in motion, and does not abide in the body in the absence of such external conditions, or after, that is on the removal of, these. Newton says the body, after the action, perseveres in its *new state* by *vis inertiae* alone; by this phrase showing that the body is not indifferent to motion, although the mass (or *vis inertiae*) is unaffected. The mass, in fact, has remained the same, while the body has acquired a new state.

On page 162 the author says that Newton expressly speaks of inertia as of a force; this is a confusion of ideas, which Newton carefully avoids, for in his remarks on Def. 3 he carefully distinguishes the passive and active aspects of matter. He says the *vis insita* (the active aspect) does not differ from the inertia of the mass (the passive aspect) except in the mode of conceiving it, and from the context, in which he says "this *vis insita* may be called by the very significant name *vis inertiae*," it is evident that here Newton fuses the two inseparable attributes of matter, *viz.*, force and inertia (p. 162), instead of confusing them.

In Chapter XII., the phrases "absolute time," "absolute space," &c., are shown to be unmeaning collocations of words, expressing nothing knowable or conceivable. The key to the attack on these pseudo-concepts is found in the opening sentence of the Chapter: "The reality of

all things which are, or can be, objects of cognition is founded on, or, rather, consists in, their mutual relations" (p. 183). On page 185 the following notable remark will be found: "The law of causality, the conservation of energy, and the indestructibility of matter, so-called, have their root in the relativity of all objective reality—being, indeed, simply different aspects of this relativity, and Newton's first and third laws of motion, &c., are but corollaries from the same principle."

Space is, according to the author (p. 235) a concept, a product of abstraction; an abstract or concept (p. 236); reached by a series of abstractions from the concepts of spatially extended forms, which concepts, in their turn, are the last result of the process of abstracting from objects their different and variable qualities attested by sensation (p. 235). Space has no properties, for, considered as an entity, it has no relations, its very essence being a denial of, or abstraction from, all relations (p. 240). The whole science of geometry is conversant about that which the concept "space" of necessity excludes, *viz.*, about determinations or limits (p. 241).

Again, the author says: "In every act of primary cognition, the objective phenomenon, so-called, and its subjective counterpart, are born (p. 235) into consciousness at the same moment, because the reality of either depends upon that of the other. This is the great primary and irreducible fact of cognition . . ." This is in answer to (p. 234) the Kantian argument that space must be a subjective form of intuition because the mind cannot barish it from consciousness. Space, not being an object of sensation, cannot be even thought of without bringing into thought with it some object of sensation (p. 233); not being an object of sensation it cannot have diversities among its constituent parts (p. 232), by which diversities matter is distinguished from space. [Here the author uses the word matter, rather inconsistently, in the sense of all bodies, instead of in the sense (pp. 149, 150) implying the concept inclusive of vis and inertia, and exclusive of all other physical attributes.]

Of Time the author says (p. 205): "The constancy of the efflux of time, like that of the spatial positions which serve as the basis for our determination of the rates and amounts of physical motion, is purely conceptual." The paragraph immediately following this sentence, which deals with the relativity of mass, is very misleading; the last sentence especially, from which the inference might be drawn that equal quantities of ice and liquid water might in some sense be considered to have different masses. For a clear statement respecting mass and its measurement the reader should consult "Maxwell's Matter and Motion," Art. xlv.

The principle of the Dissipation of Energy—as applied at least to our planetary system—is accepted by the author (p. 272). And with regard to this, as well as to the Conservation of Energy, he agrees that each of the two principles applies only to conservative systems. Now the Infinite Universe is not a conservative system, and therefore these principles do not apply to it (p. 276).

Perhaps there are liberal systems which somewhere are reversing, or sometime will reverse, the dissipating action of conservative systems. But this is a question of cosmic politics, on which the author is silent.

If the atomic theory and the kinetic theory of gases are to be suppressed, as the author intimates in Chapters VII and VIII., "modern" chemistry will disappear with them, or be so changed in outward appearance as to be unrecognisable.

P. T. MATR.

A Treatise on the Distillation of Coal Tar and Ammoniacal Liquor and the Separation from them of Valuable Products. By GEORGE LUNGE, Ph.D., F.C.S., Professor of Technical Chemistry in the Federal Polytechnic School, Zurich. London: John Van Voorst.

We have here a valuable and much needed monograph on an important and increasing branch of the chemical arts

The author, who has earned golden opinions in all industrial countries by his great work on the alkali manufacture, is here also practically at home, and though he has carefully collated the literature of the subject, he does not figure as a mere compiler. In addition to former experience, he has carefully inspected, as he tells us, "a series of the largest and best tar and ammonia works in England, France, and Germany. He also acknowledges valuable services rendered him by Mr. Watson Smith and Dr. C. Meymott Tidy. The former of these gentlemen is well known as having been formerly Prof. Lünge's assistant at the Polytechnic School of Zurich.

The author's point of view must be rightly understood in the outset. His object is to explain the processes for separating out on a large scale the useful products pre-existing in coal-tar. With their subsequent transformations and the wonderful compounds to which they give rise, he does not concern himself. In this respect he proceeds on the same principle, *e.g.*, as a metallurgist, who, whilst describing the processes for separating and refining the metals occurring in a complex ore, does not discuss their ultimate applications.

The work opens with an account of the origin of coal-tar and with a history of its successive utilisations. Attention is called to the four great classes of products obtained from the destructive distillation of organic substances; to wit, permanent gases, watery liquids, oily or tarry liquids, and solid residues, such as coke and charcoal. The gases and the solids are less modified by the nature of the body acted on than are the liquid products. The tarry products, especially, are found to vary not merely with the material, but with the temperature employed, and even with the shape and size of the retorts. Hence springs the extreme complexity of tars, the want of uniformity even in coal-tars from different sources, and the difficulty of effecting anything like a perfect separation. We cannot by any means assume that all the bodies present in coal-tar, especially the neutral and indifferent hydrocarbons, have even been detected. The historical survey of the attempts at utilising coal-tar products introduces a mention of certain facts not agreeable either to our national pride or our national pocket. We have substantially lost the manufacture of the coal-tar colours, and our home market is to no small extent supplied by Germany and Switzerland. We also come upon the suggestion that under quite conceivable circumstances it may be more remunerative to treat tar and ammonia as the main products obtainable from the distillation of coal, ranking the gases evolved as a secondary result, and thus inverting the present system. The yield of the liquid products from different kinds of coal varies greatly both in quantity and quality. Thus, whilst English coals yield on an average 4.5 per cent of tar and 6 of ammoniacal liquor, Silesian coal gives 5 to 6 of tar and 9 per cent of ammoniacal liquor.

The author points out a fact little known outside the trade, *viz.*, that the admixture of rich bituminous shales with the coal used at gas works, while it greatly improves the quality of the gas, as greatly injures the tar-products. In such cases the benzol is contaminated with hydrocarbons resembling the so-called light petroleum spirit, which is utterly useless in the colour manufacture. The anthracen is in like manner mixed with paraffin. Neither of these impurities can be eliminated by the methods of fractional distillation or crystallisation. Hence, as Dr. Lünge remarks, tar distillers often stipulate that not more than 5 per cent of oil shales, &c., must be mixed with the coal. The tar from the Boghead mineral (of Torbane Hill, now exhausted) contains toluene and naphthalene, which latter seems to accompany paraffin, but little benzol and anthracen. It appears that the coal-tar of the Scotch gas works has deteriorated with the increased temperatures employed. Twenty years ago when low heats were used the yield of benzene and its homologues was as much as 8 per cent, whilst with increasing heat it had a few years ago fallen to 3 per cent.

The recovery of the volatile products given off, and at present generally wasted in the coke ovens, is also discussed. Here it appears there is still ample room for inventive ability. Experiments in this direction are checked by the common notion, possibly a mere prejudice, that any attempt at condensing the tar, ammonia, and gas must injure the quality of the coke. It is certainly true that the coke of the gas works or retort coke, as it is called, is for metallurgical purposes much inferior to oven coke, but it by no means follows that every method of condensing the gases and vapours must interfere with the production of a compact coke. The process of Knab, as worked at St. Etienne, is said to have given 70 per cent of coke, 4 of tar, 9 of ammoniacal liquor, and 10 of gas, which last product aided in heating the ovens.

A modification of the Knab process is or has been in operation at Bessèges. According to Dr. Angus Smith (Alkali Acts, 14th and 15th Annual Reports for 1877 and 1878), each oven yielded from 9.3 to 10.6 tons of tar, and from 1.59 to 2.13 tons of ammonium sulphate yearly for 390 to 405 tons coke.

The author gives, on the authority of M. A. Hüssener, of Essen, somewhat different results. At Bessèges the products per 389 tons coke were annually 12.89 tons tar, and 6.22 tons ammonium sulphate. These results showed an annual net profit of 1114 francs per annum, not taking the coke into account. The yield of coke is 70 per cent calculated on the coal burnt, but only 60 per cent is described as being of the dense quality for blast-furnaces, the residue being half burnt and porous. The quality of the tar obtained is another serious consideration. Oven tar, according to the comparative experiments of Behrens, is poorer in benzene and toluene, and also in naphthalene, than is retort-tar. It contains more acids, but true phenol is almost wanting. Hence this problem, which may be pronounced of national importance, both from an economical and a sanitary point of view, is not yet solved.

A brief mention is made of the suggested preparation of aromatic hydrocarbons by the decomposition of fatty compounds boiling at high temperatures, that is the heaviest oils of the petroleum and paraffin refineries. Experiments in this direction have given promising results. Thus Letny, by passing petroleum "tailings" from Baku through red-hot tubes, obtained a product rich in benzene, toluene, xylene, naphthalene, and anthracen. According to Rudnew the tar from the manufacture of petroleum gas at the Kasan works is already distilled on a commercial scale, and yields from 10 to 12 per cent of benzol, and about 5 per cent of naphthalene, as well as anthracen, which is capable of being recovered. There is a mere trace of phenols. It is, perhaps, premature to give an opinion as to the future of this process. No one will deny that it would be a great advantage to the makers of artificial colours if they could at any time buy their raw materials in an open market without being under the necessity of contracting.

In the succeeding chapters of the work, Dr. Lünge treats thoroughly and fully of the properties of coal-tar and of its constituents, of its applications without distillation, of the first distillation of coal-tar, of pitch, anthracen oil, creosote oil, carbolic acid and naphthalene, of light oil and the first runnings, of rectification by steam, and of the final products. The last chapter is devoted to the manufacture of liquid ammonia. All these chapters are admirably illustrated with cuts of plant and apparatus drawn to scale whenever this feature is of importance. The processes for testing the various products so as to determine their purity and value form an important feature. This is particularly the case with anthracen. The author gives an account and an appreciation of the alcohol and the carbon disulphide tests, of Luck's method with its latest improvements, besides a process for the estimation of anthracen in tar. The appendix contains a notice of Mr. Allen's process for the determination of paraffin in anthracen, and of Mr. B. Nickels's process—

taken from Mr. Allen's "Commercial Organic Analysis," for testing anthracene.

Dr. Lünge's work does not owe its high value to the mere fact of its being without a rival. It is an admirable specimen of what an industrial monograph should be, giving us theory and practice in harmonious combination.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 9, August 28, 1882.

Dip of the Magnetic Needle.—M. d'Abbadie.—A description of a dipping-needle made by MM. Brunner.

Separation of Gallium.—Lecoq de Boisbaudran.—See page 152.

Formation of Secondary Elements of Lead Plates.—G. Planté.—The author augments the capacity of accumulation by producing a preliminary deposit of lead on the electrodes. He effects this by means of a series of changes of the direction of the primary current with intervals of rest between.

No. 10, September 4, 1882.

Distribution of Heat in the Dark Regions of the Solar Spectrum.—P. Dessains.—Not suitable for abstraction.

Typhoid Fever at Paris from 1875 to 1882.—M. de Pietra Santa.—For some years typhoid fever has assumed in Paris more alarming proportions. The deaths from this cause, which in 1865 were 1.90 per cent of the total mortality, have during the first half of the present year risen to 4.60 per cent. The mortality is greatest in the months of April and November; the distribution of the disease in the various districts of the city follows no general law, and bears no direct proportion to density of population and general mortality.

Theoretical and Practical Considerations on the Phenomena of Electromagnetic Induction. Application to the most Abundant Types of Machines.—G. Le Goarant de Tromelin.—A mathematical paper, not adapted for useful abstraction.

Law of the Thermic Constants of Substitution.—D. Tommasi.—The author gives examples in reply to the objection that his law is inapplicable when it is required to calculate the calories of combination of soluble salts formed by weak acids.

Certain Compounds belonging to the Group of the Creatinines.—E. DuVilliers.—The author gives an account of methyl-amido- α -butyro-cyamidine or creatine- α -butyric, and of methyl-amido-iso-valero-cyamidine, or iso-valeric creatinine.

No. 11, September 11, 1882.

This issue contains no chemical matter.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 6.

Influence of Cultivation of Crops in Forests on the Nature of the Soil.—Dr. Hanamann.—The author shows that such cultivation must ultimately impoverish the soil, especially in phosphoric acid.

Potassium Salts as Manure for Beetroot.—Prof. Maercker.—In moist seasons potassium chloride has no special effect; in dry seasons it increases the crop by 20 to 30 cwt. per morgen.

Manurial Experiments at Königsberg.—Dr. Klien.—In general superphosphate was more effective than precipitated.

Digestive Secretions of the Horse.—MM. Ellenberger and Hofmeister.—In the saliva of the maxillary gland there is present pytaline, a ferment capable of converting starch into sugar. In the saliva of the parotid gland there is a peptonising ferment, but in very small quantity. The mixed saliva emulsifies fats, but does not decompose them. The saliva of the horse does not dissolve cellulose.

Causes of Tuberculosis.—MM. Koch, Baumgarten, and Toussaint.—Tuberculosis is considered as a parasitic disease.

Application of the Aræometric Determination of Fat to Poor Milk.—Prof. F. Soxhlet.—In poor milks the ethereal solution of fatty matter is caused to separate by the addition of a very small quantity of potassium stearate; the oleate has no action.

Liberation of Gaseous Nitrogen in Putrefaction.—Dr. B. E. Dietzell.—The author finds, in opposition to Hufner, and in accordance with Reiset, Lawes, Gilbert, and Pugh that during the putrefaction of nitrogenous matter nitrogen escapes in the free condition. The author traces its origin to nitrous acid, which is formed in the earlier stages of putrefaction, and which evolves free nitrogen by its action upon leucine, the primary amines, and ammoniacal salts. To prevent this reaction he recommends the addition of lime.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., June, 1882.

This issue contains no chemical matter.

July, 1882.

This number contains no chemical matter save the well-known discourse delivered by M. Dumas on presenting M. Pasteur with the commemorative medal, and a popular lecture on the colouring-matters and other products of coal, by M. E. Grimaux. [We regret to find that here Philippi Lebon is put forward as the original inventor of coal-gas as a source of heat and light, though the idea had been brought forward ten years previously by W. Murdoch.]

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
Vol. 13, No. 15.

Separation and Determination of Arsenic.—Emil Fischer.

Atomic Weight of Glucinum.—Lothar Meyer.—The author considers our knowledge of relations between the atomic weights of the elements far too incomplete to warrant us in correcting the results of observations. He has already cautioned against the tendency to increase regularities by any manipulation of the stoichiometric figures as experimentally determined. He considers it theoretically possible that a member of one family may have a higher atomic weight than the corresponding member of the following family, though the atomic weights of the latter are on the average higher. We do not yet understand the causal connection between the differences of the atomic weights and the variations of properties. Differences of weight may occur which do not occasion any general change of properties, as on the other hand equality in atomic weights may be attended by a difference in properties, as in case of nickel and cobalt. Hitherto every atomic weight which at first could not be correctly inserted in the periodic series has been so corrected by repeated observations as to take its true place. This holds good with about the fourth or fifth part of the elements. Doubt prevails merely in the case of tellurium. As the result of his experiments, the author considers glucinum bivalent with the atomic weight 9.10.

A New Kind of Tetra-hedrite.—F. W. Clarke and Mary E. Owens.—The authors have examined a variety of tetra-hedrite, in which a part of the copper is substituted by lead.

The Constitution of the Antimony Tartrates.—F. W. Clarke and Helena Stallo.—The antimony tartrates have generally been regarded as containing as base the univalent group SbO . The authors endeavour to show that this assumption is superfluous, and that they all, or nearly all, are derived directly from trivalent antimony, and that some of them contain a new acid, of which the metal above mentioned is a constituent.

Isopropylen-Neurine.—H. F. Morley.—The author gives an account of the preparation and properties of isopropylen-glycol and of trimethyl-oxy-isopropyl-ammonium.

The History of the Periodic Law.—D. Mendeleeff.

The Combustion-Heat of Benzol.—Julius Thomsen.—The average result for the combustion-heat of gaseous benzol is 805,800 cal.

The Constitution of Benzol.—Julius Thomsen.—The author rejects the theory of Kekulé, maintaining that the six carbons of benzol are connected by nine single bonds. The assumption of a constitution of benzol with three single and three double bonds does not agree with experience.

The Influence of the Isomerism of the Glycols upon the Formation of their Acetic Ethers.—N. Menschutkin.—There is the most complete analogy between the monatomic alcohols and glycols as regards the influence of isomerism upon etherification.

Poly-atomic Alcohols.—N. Menschutkin.—The author examines the boundaries of the systems in which the number of the acetic molecules equals the atomicity of the poly-atomic alcohol, the etherification of poly-atomic alcohols with acetic acid in an equal number of molecules, and the etherification of the acetic systems with an excess of acetic acid.

On Calycine.—O. Hesse.—Calycine is obtained from a lichen named *Calycium chrysocephalum*. It forms gold-coloured prisms of the composition $\text{C}_{18}\text{H}_{12}\text{O}_5$.

Nature of the Caucasian Petroleum.—F. Beilstein and A. Kurbatow.—The Russian illuminating oils excel the American in luminous power by about 10 per cent. Not a trace of the aromatic hydrocarbons can be extracted from the Russian oil by agitation with fuming sulphuric acid. The hydrocarbons of the Caucasian petroleum are poorer in hydrogen than those of the American.

Quantitative Determination of Albumenoids by means of Copper Hydroxide.—G. Fassbender.—The author shows that the attempt to determine the nutritive value of organic matter by ultimate analysis is deceptive. He proceeds as follows:—100 grms. copper sulphate are dissolved in 5 litres water with the addition of 2.5 c.c. glycerin. The solution is then precipitated with a sufficient quantity of soda-lye diluted to 1.5 litre. The liquid must then have an alkaline reaction. The precipitate is poured upon a filter, drained, and rubbed up in a capsule with water which contains per litre 5 c.c. glycerin; more water is added, and the last traces of alkali are removed by repeated decantation or filtration. The precipitate is finally ground up with a little water to which 10 per cent of glycerin has been added, and preserved in well-stoppered bottles. The glycerin does not interfere with its use in the determination of the proteine compounds. (See *Berichte*, xiii., p. 251.)

Inversion of Cane-Sugar by Carbonic Acid, and certain Properties of Inverted Sugar.—E. O. von Lippmann.—Not capable of useful abstraction.

A Reply.—W. Kelbe.—An answer to the "reclamation" of H. E. Armstrong and W. A. Tilden (*Berichte*, xiii., p. 1548).

Occurrence of Saccharine in Osmosised Sugar.—E. O. von Lippmann.—Saccharin is readily formed by the action of hydrate of lime upon inverted sugar, and is readily diffusible.

Evaporation without Fusion.—Lothar Meyer.—The author refers to a paper (*Berichte*, viii., 1627), in which he showed that it depends entirely upon the pressure whether a solid when heated passes at once into the gaseous form and then becomes liquefied. He finds that iodine can be easily melted in a tube exhausted of air if the whole tube is heated to such a degree that the tension of the vapour is everywhere equal to the maximum corresponding to the temperature of the melting-point. As soon as this point is reached the iodine flows down the side of the tube in black streams. If the tube is let cool the liquid iodine begins to boil and congeals again immediately. To melt it into a compact cake it is merely necessary whilst it congeals to keep the upper part of the tube warm, so that no evaporation may occur. If the congealed mass is heated again, Leidenfrost's phenomenon is displayed very strikingly. The mass dances about, rattling loudly, supported by its own vapour. Similar phenomena can be produced with camphor, naphthalin, and perchlorethan; less completely with anthracen and alizarin. The author then criticises the communication of Mr. T. Carnelley (*Nature*, September 9, 1880), and proposes the following modification of his definitions. The "critical temperature" of a substance is that degree of heat above which no pressure is able to liquefy the gaseous substance. The "critical pressure" of a substance is that tension of its vapour below which no access of heat is able to melt the solid substance.

Picene, a New Hydrocarbon from the Tar of Lignite.—O. Burg.—Picene, $\text{C}_{22}\text{H}_{14}$, is a white hydrocarbon, much resembling chrysene. Its melting-point, corrected is 345°C . It dissolves in sulphuric acid with a green colour, and when heated forms sulpho-acids. With chromic acid and glacial acetic acid it yields a brick-red quinone, and with bromine and chlorine it forms substitution-products. It is possibly identical with the parachrysen of Rasenack and the pyro-erythrene of Berthelot.

Biebrich Scarlet.—R. Nietzki.—This colouring-matter is obtained by the action of diazo-azo-benzol upon β -naphthol. The basis of these colours is β -naphthol-tetra-azo-benzol, a bright reddish powder, insoluble in water and alkalies, sparingly soluble in alcohol, but readily in hot glacial acetic acid. Its melting point is 195° .

The Relations of Echitamine to Ditaïne.—O. Hesse.—There is no reason for considering the ditaïne salt as distinct from echit-ammonium chloride.

A Glycerin of the Sixth Carbon Series.—W. Markownikoff.—Not suitable for abstraction.

Itaconic Anhydride.—W. Markownikoff.—The author has employed the method of Gerhard and Chiozza for the preparation of anhydrides.

Action of Nitrous Acid upon Anethol.—Paul Teennies.—The author caused a solution of sodium nitrite to act upon a solution of anethol in glacial acetic acid, and obtained an addition- and a substitution-product, both which he describes.

Reactive Power of the Naphthols.—C. Graebe.—On heating β -naphthol with aniline hydrochlorate there is formed a new nitrogenous body, β -naphthyl-phenyl-amine. Phenol, under the same conditions, is not converted into diphenyl-amine or aniline. These reactions show the difference between the naphthols on the one hand and phenol on the other. The naphthols are converted by dilute sulphuric acid into the corresponding naphthyl-ethers; β -naphthyl-ether is readily obtained pure and crystalline; α -naphthol-ether much less readily.

α - and β -Naphthyl-phenyl-amine.—J. Streiff.—The author describes α -naphthyl-phenyl-amine, its hydrochlorate and picrate, α -acetyl-naphthyl-phenyl-amine, α -benzoyl-naphthyl-phenyl-amine, α -tribrom-naphthyl-

phenyl-amine, α -binitro-naphthyl-phenyl-amine, α -naphthyl-phenyl-amin-tetra-sulphonic acid, β -naphthyl-phenyl-amine, and its trisulpho-acid.

Action of Hydrochloric Acid Gas at Elevated Temperatures upon the Ultramarines of the Series Rich in Silica.—P. G. Silber.—The red ultramarine prepared for some years at the Marienberg Works is obtained by the action of gaseous hydrochloric acid along with air upon blue ultramarine, rich in silica, at a high temperature. A violet ultramarine is obtained as an intermediate product. Ultimately a yellow is produced, of little or no value, which, if heated to redness in a current of hydrogen, becomes blue again.

Cosmos Les Mondes.
No. 17, August 26, 1882.

Process for the Industrial and Economical Production of Hydrogen.—This process is founded on the decomposition of peat, lignite, or other vegetable matters capable of evolving hydrogen proto-carbide, and on the passage of the gas thus generated through a stratum of quicklime, which absorbs the carbon, becomes converted into calcium carbonate, whilst the hydrogen is set free in a state of purity.

Novel Transformation of Petroleum Oil for Lighting Purposes.—MM. Frézon, Dumont, and Francou.—The authors solidify petroleum, in which state it only burns like tallow. They effect the solidification by mixing crude petroleum (after having undergone the first distillation) with 25 per cent of the purified juice of plants belonging to the family of the *Euphorbiaceæ*. The two ingredients are put in a boiler fitted with an agitator, and heated together to about 50°, agitating the whole till the mass becomes a uniform milky fluid. When arrived at this state the mixture is distilled again and refined in the ordinary manner, when it solidifies, and may be used equally well for lighting or as a lubricant.

Numerical Relations between Thermic Data.—Dr. D. Tommasi.—The author proposes the following law:—When a metal is substituted for another in a saline solution the quantity of calories liberated is always the same for each metal, whatever may be the nature of the acid radicle which enters into the salt. Zinc, for instance, when substituted for copper in copper sulphate, liberates 50.6 cal., and the substitution of zinc for copper in any soluble salt of copper liberates always the same quantity. The author gives many examples in illustration of his law.

Annales de la Société des Sciences Industrielles de Lyon.
No. 2, 1882.

Note on Explosives.—H. Boutmy.—A compilation based on the researches of Prof. Abel and MM. Champion and Pellet.

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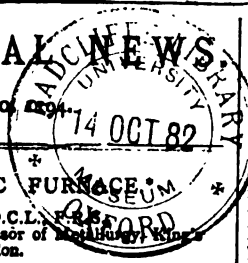
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ON THE ELECTRIC FURNACE.

By C. W. SIEMENS, D.C.L., F.R.S.,
and A. K. HUNTINGTON, Professor of Metallurgy, Royal College, London.

THE electric furnace has previously been described in the *Journal of the Society of Telegraph Engineers*, June, 1880. It has since been found advisable to surround the furnace with a coil. By this means the direction of the arc can be regulated at will, and the tendency which it has to fly to the sides of the crucible be checked.

The furnace consists of a crucible of any convenient size, in the bottom of which is pierced a hole to receive the positive electrode; the negative electrode, which passes through a hole in the lid of the crucible, being suspended from one end of a beam, the other end of which is attached to a hollow cylinder of soft iron, free to move vertically within a solenoid coil of wire. The force with which the cylinder is drawn into the coil can be counterpoised by a sliding weight on the beam. One end of the solenoid coil is connected with the positive, and the other with the negative pole. The coil having a high resistance, its attractive force on the cylinder is proportional to the electromotive force between the electrodes, i. e., to the resistance of the arc. The length of the arc is therefore regulated automatically. This is a point of great importance, as, were it not so, the resistance of the arc would rapidly diminish as the temperature of the atmosphere within the crucible increased, and the result would be that heat would be developed in the dynamo-machine. The extinction of the arc by sudden change in its resistance, or by the sinking of the material in the crucible, is thus also avoided. The crucible is surrounded with some infusible substance which is also a bad conductor of heat. Gas-retort carbon or sand answers well for the purpose. The electrodes may be of such carbon as is used in electric lighting, or of any other convenient conducting substance. They may, if desired, be cooled by circulating water through or round them, or by exposing them as far as possible to the air. For example, in one experiment a $\frac{1}{4}$ -inch nickel positive pole was employed, the lower end being inserted into a solid rod of copper about 1 inch square by 6 inches long. With this pole, no other means of keeping it cool being adopted, 1 lb. of grain nickel was fused in a clay crucible and poured in eight minutes, starting with all cold. The electrode was but little attacked, and no leakage occurred.

There are two great advantages possessed by the electric furnace, viz., that the temperature attainable is practically only limited by the refractoriness of the materials of which the furnace is constructed, and that the heat is developed immediately in the material to be fused, instead of first having to pass through the containing vessel. The temperature to be obtained by the use of fuel is limited by dissociation. Deville has shown that carbonic acid undergoes dissociation at the ordinary atmospheric pressure at about 2600°C .— 4700°F .

In the experiments made by the authors five D 2 machines, driven by a Marshall's 12 horse-power engine, were employed, one being used as an exciter. The current ranged between 250 and 300 Amperes. The most refractory clay crucibles supplied by the Patent Plumbago Crucible Company were invariably cut through in a few minutes, and, except for experiments of short duration, were useless. Plumbago crucibles stood exceedingly well. Obviously, however, they could not be employed for all purposes, owing to their tendency to cause carburisation of the metal

experimented with. In some experiments the fusion of metal was effected in a bed of lime, sand, or electric light carbon-dust. The latter is a very bad conductor, and, as in the case of lime and sand, allows the arc when once formed to maintain a passage through it to the metal beneath.

Wrought-Iron.—Six pounds of wrought-iron were kept under the action of the arc for twenty minutes, and the metal then poured into a mould. It was found to be crystalline, and could not be forged. This is the result which has always been obtained when iron, nickel, or cobalt have been fused. Although the remedy, viz., the addition of a little manganese just before pouring, is well known, the cause remains still unexplained.

Steel.—As much as 20 lbs. of steel files have been melted in one charge, the time required being about one hour, starting with the furnace hot. With such large quantities the metal has invariably been full of blowholes.

White iron, fused in a clay crucible for thirty minutes, when fractured did not appear to have undergone any change. White iron and coke were introduced into the furnace; the resultant metal was slightly greyer than the original. When, however, retort carbon was substituted for the coke, a good grey iron, soft and easily workable, was readily obtained in fifteen minutes, starting with the crucible hot. On another occasion, starting all cold, at the end of thirty minutes the metal, although it had been well fused, had not been rendered greyer. The difference between these two results was possibly due to the temperature being somewhat higher in the one case than in the other. This is a point of considerable practical interest. Four pounds of white iron, fused with carbon-dust for three-quarters of an hour, yielded a very grey crystalline iron. In another experiment, in which 8 ounces of grey iron, produced in the electric furnace from white iron, were re-melted in carbon-dust for ten minutes, a very grey metal was obtained, from which on slow cooling a large quantity of graphite separated.

Cast-iron, fused and kept under the action of the arc for forty-five minutes in carbon-dust, was not materially changed as to greyiness, and the general character of the metal as to the way in which it worked under the tool was not materially altered. The object of the experiment was to ascertain the maximum amount of carbon iron is capable of taking up under circumstances presumably the most favourable. The result is hardly that which would have been anticipated. Some of the same cast-iron was fused for fifteen minutes under lime, which nearly covered it. The character of the fracture of the metal was but little altered by this treatment, when slight differences, due to the rate of cooling, are taken into account. A strong smell of phosphuretted hydrogen or of a phosphide was perceived—probably the latter. This was only observed in the experiment in which lime was used. The lime employed still retains a very offensive odour.

When *spiegeleisen* was fused in a plumbago or a clay crucible, graphite separated as the metal cooled.

Siliceous pig iron, containing about 10 per cent silicon, was fused by itself; it showed but little change, except that some graphite separated. A similar result was obtained when 5 lbs. of the siliceous pig were fused for one hour in carbon-dust. On fracturing the ingot obtained, a large quantity of scales of graphite was found in a hollow which traversed nearly the whole length of the ingot at its centre. The fracture of the metal was still that so characteristic of highly siliceous iron, and was practically the same as that of the original pig-iron.

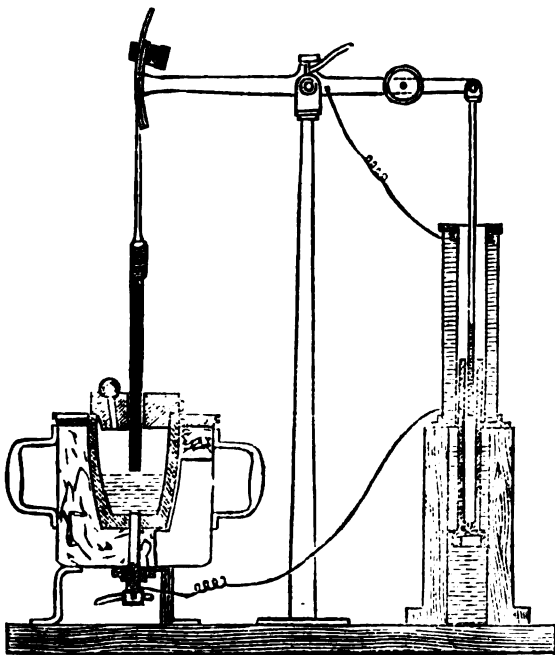
A series of experiments was made to determine the maximum amount of carbon pig-iron is capable of taking up in the presence of a given quantity of silicon. Grey cast-iron and pig-iron containing 10 per cent of silicon were fused together in carbon-dust, the ratio between them being varied so as to yield metal with from $\frac{1}{2}$ per cent to 9 per cent of silicon.

A similar series was made, only substituting sulphur for silicon. No odour of sulphurous acid was perceived;

* Read before Section B of the British Association at Southampton.

therefore, presumably, no sulphur was volatilised. This is somewhat remarkable, considering the nature of the experiment. It was thought that investigations of this kind might have an important practical as well as more purely scientific interest—admitting, for the sake of argument, that any such distinction really exists—in assisting to determine the conditions in the blast-furnace, &c.

Nickel.—A positive pole of this metal,—cast malleable by Wiggin and Co.'s process,*— $\frac{1}{4}$ inch in diameter, was passed through a hole in the bottom of a clay crucible. A carbon negative pole was used, but soon after the commencement of the experiment a deposit of nickel formed on the end of it, so that practically it was a nickel pole. This deposition of metal on the negative pole was also observed with some other metals—namely with tungsten. Without disclaiming any special knowledge on the point, Prof. Huntington suggested whether this phenomenon—which is the reverse of that generally recognised as taking place—might not depend on the relative volatility of the matter composing the poles. In the furnace arranged as just described, 1 lb. of grain nickel was fused and poured in eight minutes. The fused metal had a brilliant granular fracture. It could not be cut properly in the shaping machine, shearing off under the tool. One pound of grain nickel fused in carbon-dust for twenty-five minutes yielded a dark grey carburised metal, which worked well under the tool. On another occasion an equal quantity of nickel, similarly treated, gave a "blowy" metal, which could not be worked. Some carburised nickel, made as described above, was fused in a clay crucible for twelve minutes, and allowed to cool gradually in the furnace; the fracture became whiter, and the grain closer.



Copper.—Three-quarters of a pound of copper were fused for about half an hour in carbon-dust. On examining the result it was found that all but about $\frac{1}{2}$ oz. had been vapourised. Those who were present during the experiments suffered no ill effects from the atmosphere charged with copper, which they must have breathed.

Platinum.—Eight pounds of platinum were rendered perfectly liquid in about a quarter of an hour.

* See paper on "Nickel and Cobalt," by A. K. Huntington, in July number of the *Journal of the Society of Chemical Industry*.

Tungsten.—Half a pound of tungsten in powder was subjected to the action of the arc in a clay crucible. Dense fumes were evolved, a cavity about 1 $\frac{1}{2}$ inches across the top being formed. The furnace was allowed to cool down slowly. When the crucible was removed it was found to have been very much attacked below the point to which the arc extended. The inference is that the crucible had been attacked by the metal at the temperature of the experiment. The metal was fused only to an inappreciable depth beneath the cavity formed by the arc. The unfused metal underneath was covered with very beautiful iridescent crystals of tungsten, which under the microscope appeared to be well-formed prisms. They have not yet been measured. The crystals had evidently been formed by the slow cooling of the vapour distilled down from the surface.

A very large number of experiments was made with tungsten, the results of which showed that it could not be fused, except in very small quantities at a time. It was possible to build up a small ingot by fusing a little of the tungsten, and then adding little by little gradually. Even then the pieces obtained were for the most part spongy and unsatisfactory. The best results arrived at were when tungsten which had already been fused was employed in the building-up process. Once the metal had been fused, it did not fume much in melting, doubtless owing to the greatly reduced surface exposed.

Tungsten fused in the electric furnace is, when untarnished, pure white and brittle, the grain being very close. Tungsten hitherto has only been obtained as a grey powder, by reducing the oxide with carbon or hydrogen, or in minute globules in the ordinary small electric arc. Tungsten has its fusing-point lowered by the addition to it of carbon. Under these conditions a solid piece of moderate size can, without much difficulty, be obtained. From 1000 grains of powder fused in carbon-dust, 650 grains were recovered, the remainder having been volatilised, and from 450 grains of the fused metal 410 grains were obtained on re-fusion. One piece of tungsten which had been treated under the conditions most likely to cause it to be highly carburised was analysed. It contained 1.8 per cent of carbon. The metal was very white, close in grain, and brittle.

From the foregoing experiments it is clear that the amount of any given metal which can be successfully fused in the electric furnace, and the time required in effecting the fusion, are dependent on (a) the relation between the volatilising point and the fusing point, i. e., the extent to which the volatilising point is higher than the fusing point; (b) the conductivity of the metal for heat.

It thus happens that platinum can be more readily melted than steel, and in greater quantity for a given expenditure of energy. This inference is believed by Prof. Huntington to be justified by the observations and experiments so far made.

It still remains to examine chemically the specimens referred to in this paper.

In the discussion on the communication made by Prof. Huntington, Dr. SIEMENS remarked that the limit of the temperature producible by means of the electric furnace is as yet unknown, for although the heat would probably increase the resistance of the arc, that in itself would only cause a further development of heat. The results obtained with copper, although apparently pointing to a drawback in the use of the furnace for melting purposes, yet might prove of importance in dealing with metals in the vaporous condition. He could not agree with Prof. Huntington's suggestion as to the cause of the deposition of metal on the negative pole. He thought it was due to the negative pole being much cooler than the positive.

Dr. GLADSTONE inquired whether the deposit was crystalline or in fused globules.

Prof. HUNTINGTON replied that it was in the latter condition.

Mr. TERRILL (Swansea) remarked that the loss of copper by volatilisation in smelting was much greater than it was

generally supposed. During an accidental escape of sulphuretted hydrogen in the works he had observed a thick deposit of sulphide of copper extending over a large area. He had detected copper deposited even on the zinc counter of the refreshment bar at the railway station some distance from the works.

The discussion was continued by Mr. MAXWELL LYTE, Prof. VERNON HARCOURT, and the president, Prof. LIVEING, who thought that such experiments as had been made might be of great service in the study of metals.

RATTLESNAKE POISON.

By HENRY H. CROFT,

Late Professor of Chemistry, &c., Toronto, Canada.
Formerly part Editor and originator of the *Chemical Gazette*.

SOME time since, in a paper to which I am unfortunately unable to refer, a French chemist affirmed that the poisonous principle in snakes, or eliminated by snakes, was of the nature of an alkaloid, and gave a name to this class of bodies.

Mr. Pedler has shown that snake poison is destroyed or neutralised by means of platonic chloride, owing probably to the formation of an insoluble double platonic chloride, such as is formed with almost if not all alkaloids.

In this country (Texas) where rattlesnakes are very common, and persons camping out much exposed to their bites, a very favourite antidote, or *remedia* as the Mexicans call it, is a strong solution of iodine in potassium iodide.*

I have had occasion to prove the efficacy of this mixture in two cases of *cascabel* bites, one on a buck the other on a dog, and it occurred to me that the same explanation of its action might be given as above for the platinum salt, viz., the formation of an insoluble iodo compound as with ordinary alkaloids if the snake poison really belongs to this class.

Having last evening killed a moderate sized rattlesnake — *Crotalus horridus*—which had not bitten anything, I found the gland fully charged with the white opaque poison; on adding iodine solution to a drop of this a dense light-brown precipitate was immediately formed, quite similar to that obtained with most alkaloids exhibiting under the microscope no crystalline structure.

In the absence of iodine a good extemporaneous solution for testing alkaloids, and perhaps as snake poison antidote, may be made by adding a few drops of ferric chloride to solution of potassium iodide: this is a very convenient test agent which I used in my laboratory for many years.

Although rattlesnake poison could be obtained here in very considerable quantity, it is out of my power to make such experiments as I could desire, being without any chemical appliances and living a hundred miles or more from any laboratory. The same may be said with regard to books, and possibly the above iodine reaction has been already described.

Dr. Richards states that the cobra poison is destroyed by potassium permanganate; but this is no argument in favour of that salt as an antidote. Mr. Pedler also refers to it, but allows that it would not be probably of any use after the poison had been absorbed. Of this I think there can be no doubt, remembering the easy decomposition of

permanganate by most organic substances, and I cannot but think that the medicinal or therapeutic advantages of that salt, taken internally, are equally problematical, unless the action is supposed to take place in the stomach.

In the bladder of the same rattlesnake I found a considerable quantity of light brown amorphous ammonium urate, the urine pale yellow.

Hermanitas Ranch, 35 San Diego, Duval Co.,
Texas, U.S., August 22, 1882.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

(Continued from p. 152).

Separation from Uranium (yellow uranic salts). The four following methods are suitable for exact analyses:—

1. The hydrochloric solution, slightly acid, is treated at a boil with an excess of cupric hydrate. The deposit contains all the gallium as well as a very sensible portion of uranium. It is re-dissolved in hydrochloric acid, diluted with water, and boiled in presence of a large excess of cupric hydrate. With from 10 to 15 parts of uranium to 1 of gallium, four successive precipitations are required. The uranium is then entirely contained in the liquids which are acidified, and are then traversed by a current of sulphuretted hydrogen. Copper sulphide is deposited, and the salt of uranium is obtained on evaporating the filtrate.

2. If there is iron to remove along with uranium it is first reduced in heat with metallic copper and then boiled with an excess of cuprous oxide. Four successive operations suffice to separate completely 1 part gallium from 10 to 15 parts uranium. The presence of very considerable quantities of alkaline salts does not interfere with the execution of the two methods just described, which may serve for the analysis of a mixture of gallium and of an alkaline uranate.

3. The hydrochloric solution, slightly acid, is mixed with an excess of acid ammonium acetate, as also a certain quantity of zinc free from gallium, and is then treated with a current of sulphuretted hydrogen. The zinc sulphide carries down the gallium, whilst the uranium remains in solution. Only the zinc sulphide being very difficult to wash ought to be re-dissolved in hydrochloric acid and re-precipitated in an acetic solution. The gallium is separated from the zinc as was described previously (*Comptes Rendus*, June, 1882, p. 1628). The uranium is separated by evaporating the liquids with an excess of hydrochloric acid to expel acetic acid, and then destroying the ammoniacal salts with *aqua regia*. It is essential to add to the liquid so much zinc chloride that the zinc sulphide may carry down all the gallium. Some drops of zinc chloride should be added to the filtered hydro-sulphuretted liquids to ascertain the absence of gallium in this last zinc sulphide. Alkaline salts do not interfere with the separation of uranium and gallium by means of zinc sulphide. The present process is suitable for the detection of small traces of gallium in large masses of uranic compounds, especially in presence of metals such as aluminium. But in ordinary cases it is better to make use of the reactions of copper hydrate or of metallic copper and cuprous oxide.

4. Uranium may be precipitated by a slight excess of caustic potassa as an alkaline uranate, scarcely retaining a slight trace of gallium, which may be entirely removed by re-dissolving in hydrochloric acid and re-precipitating with potassa. The alkaline liquids collected contain all the gallium and traces of uranium. These liquids are slightly supersaturated with hydrochloric acid mixed with an excess of cupric hydrate and raised to a boil, when the gallium is completely precipitated. In the filtrate, copper, uranium, and potassium are separated by known methods. When the potassa employed contains a little carbonate (a

* The solution is applied as soon as possible to the wound, preferably enlarged, and a few drops taken internally. The common Mexican *remedia* is the root of the *Agave Virginica* mashed or chewed and applied to the wound, while part is swallowed.

Great faith is placed in this root by all residents here, who are seldom without it, but I have had no experience of it myself; and the internal administration is no doubt useless.

Even the wild birds know of this root; the queer Paisano (ground woodpecker) which eats snakes, when wounded by a *vibora de cascabel*, runs into the woods, digs up and eats a root of the *Agave*, just like the mongoose; but more than that, goes back, polishes off his enemy, and eats him. This has been told me by Mexicans who, it may be remarked, are not always reliable.

frequent case) the proportion of uranium not precipitated is sensibly increased; this is without inconvenience, since the separation of this gallium and of the dissolved uranium is effected afterwards by the action of cupric hydrate.

Separation from Lead.—This may be effected in six methods:—

1. The hydrochloric solution, slightly acid, is diluted with a little water and submitted to ebullition in presence of an excess of cupric hydrate. The gallium precipitated retains but a feeble trace of lead, which is entirely eliminated by a second similar treatment. The reagents employed must be free from sulphuric acid or sulphates, or otherwise lead sulphate will remain upon the filter along with gallium oxide. The copper and the lead are then separated by known methods. The present process is very exact, and is suitable for removing from gallium sulphate the small quantity of lead which remains in solution after precipitation with sulphuric acid.

2. The separation of lead is also effected accurately if the hydrochloric or sulphuric solution is boiled first with metallic copper and then with cuprous oxide. This method is especially applicable when iron has to be separated at the same time as lead. The first cuprous precipitate contains scarcely a feeble trace of lead, so that two operations are sufficient. If we operate upon a chloride the presence of sulphuric acid must be carefully avoided.

3. The solution, sulphuric, hydrochloric, or nitric, perceptibly though moderately acid, is saturated with hydrogen sulphide, filtered, and evaporated almost to dryness, in order to expel the bulk of the free acid. It is then diluted with water, and again saturated with hydrogen sulphide. After two or three similar treatments, the salt of gallium no longer contains an appreciable trace of lead. The lead sulphides generally retain a trace of gallium, which may be removed by attacking them with concentrated hydrochloric acid, adding alcohol, filtering, evaporating to expel the alcohol and the bulk of the acid, diluting with water, and finally saturating with sulphuretted hydrogen.

4. In a liquid containing from one-fourth to one-third of its volume of strong hydrochloric acid, potassium ferrocyanide precipitates gallium ferrocyanide, generally free from lead. In case of need the gallium salt may be taken up in a small quantity of potassa and re-precipitated by adding much hydrochloric acid and a little potassium ferrocyanide.

5. It is often convenient to begin by precipitating almost all the lead by means of sulphuric acid. The liquid is then mixed with double its volume of alcohol at 90°. If properly washed with alcohol, acidulated with sulphuric acid, the lead sulphate does not contain appreciable traces of gallium. To detect such traces the lead sulphate is suspended in water, acidulated with hydrochloric acid, and treated with a prolonged current of hydrogen sulphide. The filtrate is boiled in order to expel hydrogen sulphide, and treated in heat with cupric hydrate, which precipitates the traces of gallium oxide. The alcoholic solutions derived from the sulphuric precipitation of lead are freed from alcohol by boiling; the gallium oxide is then separated by means of cupric hydrate.

6. The solution (nitric or other) is mixed with twice its volume of alcohol at 99 per cent, and a small excess of hydrochloric acid. The lead chloride when washed with acidulated alcohol does not retain gallium. The alcoholic liquids are concentrated to a small volume, freed from nitric acid, and treated either with hydrogen sulphide (process No. 3), or with cupric hydrate, or metallic copper and cuprous oxide (processes Nos. 1 and 2).—*Comptes Rendus*.

New Work on Dyeing.—We learn that Messrs. Palmer and Howe, of Manchester, have in the press a new work on dyeing by Mr. David Smith, of Halifax. The work will contain 500 dyed patterns of cotton yarns, cotton wool, worsted yarns, wool, and silk in the skein, each accompanied by a practical receipt.

CHEMICAL LITERATURE.

AN ADDRESS DELIVERED BEFORE THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AT MONTREAL, AUGUST 23, 1882.

By Prof. H. CARRINGTON BOLTON, Ph.D., Vice-President.

(Concluded from p. 148).

As we proceed with this review of chemical literature, the publications increase enormously in number, variety, and importance, and the end of our undertaking seems to move forward faster than we progress. It is manifestly impossible in the brief time allotted to this address to analyse the chemical literature of the preceding hundred years. How shall we attempt to portray the theories and experiments recorded in the writings of Bergmann,* Scheele† and Gahn, the eminent Swedes; of Black,‡ Cavendish,§ and Priestley,|| the English triumvirate; of the French philosophers Fourcroy,¶ de Morveau,** and Lavoisier;†† of the industrious German chemists Kunckel,‡‡ Marggraf,§§ Wenzel,||| Klaproth,¶¶ and Richter;*** or of the Italian philosophers Galvani,††† Volta,†††† and Brugnatelli?§§§ And passing to a later period, how shall we do justice to the labours of Berthollet,||||| Gay-Lussac,¶¶¶ Thénard,**** and Laurent;†††† of the immortal Dalton,††††† of the brilliant Davy,§§§§ of the indefatigable analyst Berzelius;||||| of Mitscherlich, Liebig, Wöhler, and Hofmann; of Dumas, Berthelot, and Adolph Wurtz; of Graham, Frankland, Abel, and Crookes?

American contributions to chemical literature have been exhaustively discussed in the hearing of many present and need not now detain us; I refer to Prof. Silliman's Address at the celebration of the centenary of Priestley's discovery of Oxygen, held at Northumberland in 1874.¶¶¶¶

(Works marked (a) are in the private library of the author.)

- * Torbern Bergmann, *Opuscula physica et chemica*. 6 vols., 1779-1790. Cf. (a) "Physical and Chemical Essays," translated by Edmund Cullen. London, 1784. 2 vols. 8vo.
- † Carl Wilhelm Scheele, *Opuscula chemica et physica*. Leipzig, 1788. Cf. (a) *Mémoires de Chymie*. Dijon, 1785. 2 vols. 12mo.
- ‡ Joseph Black, "Lectures on Chemistry." London, 1803. Cf. An (a) American edition published at Philadelphia in 1807. 3 vols. 8vo.
- § Henry Cavendish, (a) "The Life of Henry Cavendish, including abstracts of his more important scientific papers," by George Wilson. London, 1851. "Electrical Researches," edited from the original MSS., by J. Clerk Maxwell. Cambridge, 1881.
- || Joseph Priestley, (a) "Experiments and Observations on different kinds of Air." London, 1775. 4 vols. Priestley's earliest chemical paper was entitled: (a) "Directions for impregning Water with Fixed Air." London, 1772.
- ¶ A. Fr. de Fourcroy, *Système des connaissances chimiques*. Paris, 1801; *Tableaux synoptiques de chimie*, Paris, 1799; *Mémoires et Observations de chimie*. Paris, 1784.
- ** Guyton de Morveau, (a) *Méthode de nomenclature chimique*. Paris, 1787. *Elements de chimie... pour servir aux Cours publics de l'Académie de Dijon*, 1777. *Encyclopédie méthodique de chimie*, 1786.
- †† Ant. Laurent Lavoisier, *Oeuvres complètes*. Paris, 1862.
- ††† Johann Kunckel, *Collegium physico-chymicum experimentale seu Laboratorium chymicum*. Berlin, 1716. [(a) *Vierte Aufl.*, 1767].
- §§ Andreas Sig. Marggraf, *Chymische Schriften*. Berlin, 1761 and 1767. 2 vols. 8vo.
- ||| Carl Fr. Wenzel, *Vorlesungen über die chemische Verwandtschaft der Körper*. Dresden, 1777. 8vo.
- ¶¶ Martin H. Klaproth, *Beiträge zur chemischen Kenntniss der Mineralkörper*. Berlin, 1795-1813. 6 vols. 8vo.
- *** J. B. Richter, *Stöchiometrie oder Messkunst chymischer Elemente*. Breslau, 1792-1794. 3 vols.
- ††† Luigi Galvani, *Opere edite ed inedite*. Bologna, 1831. 4to.
- †††† Alessandro Volta, *Collezione dell'opere* [edited by V. Antonini]. Firenze, 1816. 3 vols. 8vo.
- §§§ Luigi Brugnatelli, *Elementi di chimica*, Pavia, 1795. 2 vols.; also *Annali di chimica*, 1790-1793, and several other periodicals.
- |||| Claude Louis Berthollet, *Essai de Statique chimique*. Paris, 1803. 2 vols.
- ¶¶¶ Gay-Lussac, *Recherches physico-chimiques faites sur la pile, &c.*, Paris, 1811. 2 vols. 8vo.
- **** Louis Jacques Thénard, *Traité de chimie élémentaire*. Paris, 1813-16. 4 vols. 8vo.
- †††† Auguste Laurent, "Chemical Method," translated by Wm. Odling. London, 1855.
- ††††† (a) John Dalton, "A New System of Chemical Philosophy." Manchester, 1808. 2 vols. 8vo.
- §§§§ Sir Humphry Davy, "Collected Works," edited by John Davy. London, 1839-41. 10 vols. 8vo.
- ||||| J. J. Berzelius, *Lehrbuch der Chemie*. [(a) *fünfte Auflage*. Leipzig, 1836. 6 vols. 8vo.]
- ¶¶¶¶ (a) Benjamin Silliman, "American Contributions to Chemistry,"—in the *American Chemist*, vol. 3, p. 70. Philadelphia, 1874.

The modern period of chemical literature is characterised by two opposing forces, a tendency to dispersal and an effort to collect the widely-scattered publications. The multiplication of learned societies, especially in Europe, each of which supports its own organ, and the increasing number of nations interested in scientific pursuits, in each of which arises an independent periodical, tend to the wide dispersal of memoirs, essays, and notices.

On the other hand, industrious editors laboriously collect and set in order these scattered observations, constructing compact, massive handbooks, and many volumed cyclopædias. The monumental work of Gmelin, which is even now passing through another edition, has worthy rivals in the magnificent compilations edited by Henry Watts and by Adolph Wurtz, and in the work of Beilstein in a field of special difficulty. For systematic treatises we can point to Miller, Graham-Otto, Pelouze et Frémy, Roscoe and Schorlemmer, and the ever youthful Fownes.

Invaluable, too, are the annuals known as *Jahresberichte*, monuments of conscientious editorship.

Another feature of modern growth is the multiplication of special treatises dealing with single topics in every branch of chemistry, inorganic, organic, theoretical, analytical, technological, pharmaceutical, and physiological, until mere acquaintance with their titles becomes a serious undertaking for busy workers in the laboratory.

The amount of time and labour required to search for a given point throughout the maze of modern chemical journals, transactions, treatises, and handbooks, is well appreciated by my audience; the superb dictionaries and annuals referred to accomplish much in cataloguing, condensing, and systematising the infinity of observations; nevertheless, all working chemists feel the need of special indexes, simply arranged, as complete as possible, and accessible to every one. Sharing in this feeling, I have contributed my mite to the literature of chemical indexes, and have inspired several friends, fellow-members of this Association, with the courage to follow. Uranium,* Manganese,† Titanium,‡ Vanadium,§ Ozone,|| and Peroxide of Hydrogen,¶ have been indexed on a uniform plan, and my pupil W. W. Webb, B.S., has prepared an Index to the Literature of Electrolysis,** which will soon be published in the same channel as the others:—the "Annals of the N. Y. Academy of Sciences."

Pardon, we beg you, these personal allusions: we have indulged in them with the object of bringing before this Section a proposition for organised effort in the preparation of Indexes to all the Elementary Substances on a uniform plan.

The advantages which would accrue from the publication of special indexes to the literature of the elements and of such other subjects as may prove desirable are too obvious to need argument; I have thought that the undertaking might be placed in the hands of a Committee of the Chemical Section of this Association. The existence of an Index Society in England under the guidance of Henry B. Wheatley, F.S.A., Hon. Sec., affords a precedent, if indeed any be required.

The first duty of the Index Committee of the Section of Chemistry would be to secure volunteers willing to undertake the compilation of special indexes; surely in this National Association a few chemists can be found ready to coöperate in such an important work. The Committee would further adopt a uniform plan for the indexes, deter-

mine the method or channel of their publication, and exercise general editorial supervision over the undertaking.

Hoping that this suggestion will receive your approbation I leave it in your hands.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

By A FOREIGN VISITOR.

ALTHOUGH twenty years younger than its great prototype, the British, this Association is nevertheless in active and vigorous growth. The thirty-first meeting, which has just concluded its session at Montreal, will henceforward rank as one of the most successful of its many successful reunions. Favoured with splendid weather (not so hot as the usual Canadian summers), a picturesque and yet important commercial city wherein to assemble, and a most energetic and liberal Local Committee, how could anything go wrong? But success means work, and this fact every member of the executive seemed to realise, for all worked with a will.

To give names under these circumstances would seem invidious, but three gentlemen stand out in such prominence that any account of the 1882 meeting would be incomplete were they not specially mentioned. This Montreal Triumvirate consisted of Dr. T. Sterry Hunt, F.R.S., the Chairman of the Local Executive; Mr. F. W. Putnam, the Permanent Secretary of the Association; and Prof. H. T. Bovey, the Secretary of the Local Committee on Excursions, and may every Society have such disinterested workers!

The head quarters of the Association were situated at McGill University, but some of the larger meetings were held in the Queen's Hall (a very fine building), in the heart of the city. *En passant* we may say that McGill University was founded by the generosity of the Hon. James McGill, a native of Glasgow, but a resident of Montreal. This gentleman, who died in 1813, left 47 acres of land and £10,000 in money, "to erect and establish a University or College for the purpose of Education and the advancement of learning in the Province of Lower Canada." The first session commenced in the autumn of 1821, when a Royal charter was granted. Since that it has grown slowly and steadily, until to-day it ranks as one of the leading universities of the American continent. This success has been greatly due to the munificence of many of the leading citizens of Montreal, who have contributed large sums to the funds at the disposal of the Governors. The Principal of the College, Dr. J. W. Dawson, F.R.S., was President of the Association for the meeting, and it is needless to say the University was exceedingly well represented.

The arrangements of the Local Committee were very complete and satisfactory. They are, however, in many respects so different, owing to circumstances, to those in use by us that a short account of them may not be out of place. In the first place every railway company owning lines running into Montreal agreed to take members to and fro for a single fare. As it is the custom for the head of the family to bring his wife, and perhaps a daughter or two, this becomes an important concession. Upon registering their names, members receive a handbook of Montreal and a badge stamped with the number against his or her name on the register. This badge it is expected will be worn during the meeting. The handbook was exceedingly well done, and contained a good map of the town, which we strangers found of immense service. Luncheon was provided daily in a spacious marquee erected in the College grounds. The telegraph companies showed their sense of the presence of the representatives of science in their midst by placing, in a room of the College set apart for that purpose, transmitting and re-

* H. C. Bolton, "Index to the Literature of Uranium." *Annals N. Y. Lyc. Nat. Hist.*, IX, Feb., 1870.

† H. C. Bolton, "Index to the Literature of Manganese." *Idem*, XI., Nov., 1873.

‡ Edw. J. Hallock, (a) "Index to the Literature of Titanium." *Annals N. Y. Acad. Sci.*, I., p. 33.

§ G. J. Rockwell, (a) "Index to the Literature of Vanadium." *Idem*, I., p. 133.

|| A. R. Leeds, (a) "Index to the Literature of Ozone." *Idem*, I., p. 373.

¶ A. R. Leeds, (a) "Index to the Literature of Peroxide of Hydrogen." *Idem*, I., p. 416.

** W. W. Webb, "Index to the Literature of Electrolysis." *Idem* vol. II., p. —.

ceiving instruments, and a telephone, and keeping an operator in attendance. Messages could be sent by members to any part of the United States or Canada free of charge. I fear our Government do not treat British men of science with like liberality. Again, any parcels of books, drawings, instruments, or specimens were delivered free of charge by the various Express companies. The Collector of Customs admitted such parcels from the States free of duty. But perhaps the most surprising to an English visitor was the extraordinary generosity of the railway companies in the matter of excursions. Three of these were arranged, one on Saturday, August 26, to Ottawa (112 miles from Montreal) and back, another starting on Friday night and returning on Saturday down the St. Lawrence to Quebec (160 miles from Montreal), and the third to Lake Memphremagog (120 miles) on Thursday, August 31. (The distances of these excursions are worth noting: imagine the British Association at its last meeting running excursions to Plymouth, Canterbury, and Gloucester!) In each of these cases special trains were placed at the service of the scientists. In the Quebec excursion, the Richelieu and Ontario Steamboat Company provided dinner for 500 free of cost, and the South Eastern R. R. Company, who gave the Memphremagog excursion, not only provided dinner for a like number, but chartered a steam-boat to take them for a trip on this beautiful lake. In addition to this every member could go any morning or evening simply by showing his badge by the Grand Trunk R.R. to Lachine, then embark on board a steamboat, and come down the Lachine Rapids under the Victoria Bridge to Montreal.

The proceedings were opened on Wednesday, August 23, by a General Meeting in the Molson Hall of McGill College. Here the retiring President, Prof. Geo. J. Brush, resigned the chair to Dr. Dawson, the incoming President. An invocation by the Right Rev. Bishop Bond followed, after which Dr. Hunt gave a short History of the Association, which was then formally welcomed to the city by the Hon. J. L. Beaudry, the Mayor. The President next announced the names of the foreign visitors, as follows:—Dr. W. B. Carpenter, Dr. J. H. Gilbert, and Dr. Rae, from London; Dr. Haughton, from Dublin; Mr. E. H. Cook, from Bristol; Prof. Szabo, from Buda Pesth; Prof. W. Kowalevski, from Moscow; and M. Rudolph Koenig, from Paris. Each of these contributed one or more papers to the Association. In addition there were present Dr. Fitzgerald and Messrs. Ormsley and McCays, from Dublin; Rev. Prof. Wiltshire and Mr. J. S. Shene, from London; Mr. J. Cox, from Cambridge; and Herr C. Wedl, from Vienna.

After a resolution had been carried to cablegram to Dr. Siemens at Southampton, the meeting adjourned for lunch provided by the Local Committee. In the afternoon the addresses of the Presidents of the Sections were given. The total number of persons registered amounted to 937, a number that has only been exceeded once before, viz., at the Boston meeting two years ago. The total number of papers read amounted to 256, divided between the nine sections. In addition to this there was the address of the retiring President, Prof. Brush, on "Mineralogy," addresses by the Vice-Presidents in eight of the sections, and two public lectures, one by Dr. Carpenter on "The Temperature of the Deep Sea," and one by Prof. Alexander Melville Bell on "Visible Speech." It is thus evident that no one could complain of the amount of scientific pabulum provided, and the quality was also of a high order. It may interest the curious, and perhaps also the critical, to know that out of the 937 persons registered no less than 367 were ladies, who contributed eight papers to the number read. The whole of the addresses of the various Vice-Presidents were highly interesting, and every paper communicated was of scientific interest. Among those which attracted most attention we may perhaps mention Sir J. B. Lawes and Dr. Gilbert on "Sources of Nitrogen in Crops," read before Section C., and

ordered to be printed *in extenso*; Dr. Haughton's paper upon "Possible Geological Consequences of the Evolution of the Earth-Moon System," in which he notices and criticises Mr. Darwin's recent work; Prof. Asa Gray "On the Flora of North America," a summary of the knowledge acquired during a life-long study of the subject; Dr. John Rae's most interesting account of his Arctic Explorations in search of traces of Sir John Franklin; Prof. A. Graham Bell on his experiments in finding the position of a bullet when hidden in the body, with exhibition of the apparatus; Prof. H. A. Rowland's exhibition of his beautiful diffraction gratings; and last, but not least, M. Koenig on the "Influence of Harmonics on the Timbre of Sound."

During the meeting Mr. Peter Redpath formally presented his new Museum to Principal Dawson for the use of McGill University. This really fine building stands in the College grounds, at a short distance from the main building, and has been erected and fitted up at the sole expense of the generous donor, an expense estimated at 100,000 dollars. Its cases are already well-filled, including Dr. Dawson's collection, which he has recently presented to McGill University, and also the very fine collection of shells left by Dr. P. Carpenter, of Montreal.

The meeting of 1882 will long be remembered by the visitors from this side of the Atlantic. Not only were they treated to science of a very high class, but the cordial and generous manner in which they were received is seldom equalled, and never excelled. We had heard of the hospitable character of the Canadian and American people, and our expectations were great: we have now experienced this hospitality, and our expectations were greatly surpassed. Moreover, in the ability and enthusiasm displayed by all the younger men we could not help feeling that in such hands American science must flourish and must extend its operations to the benefit of mankind in general.

We cannot conclude this brief notice without placing on record and heartily endorsing the sentiments expressed in the address of welcome presented to us by the citizens of Ottawa:—"The mission of Science is not only to civilise the nations; it is also in an eminent degree to unify them by increasing the intimacy at once of social and international relations, and by creating for the contemplation and use of all a solid body of truth whose authority is wholly independent of latitude and longitude. The writ of science runs throughout the universe. . . . Let us at the same time express the hope that the great English-speaking branches of the human family may ever draw nearer to one another in heart, and so encourage and strengthen one another, in the practice of every national virtue, and in the promotion of peace, progress, and human happiness throughout the world."

NOTICES OF BOOKS.

On Artificial Manures: their Chemical Selection and Scientific Application to Agriculture. A Series of Lectures given at the Experimental Farm at Vincennes during 1867 and 1874-5. By M. GEORGES VILLE. Translated and Edited by WILLIAM CROOKES, F.R.S. Second Edition, thoroughly revised. London: Longmans and Co.

M. VILLE has come forward at a critical point in the career, not merely of English but of European agriculture. Rapid steam navigation and cheap land conveyance on both sides of the Atlantic have rendered it possible for the American producer of corn, cattle, cheese, &c., to compete with the British and the French farmer in their own markets. The question arises what is to be done? Taxes on the introduction of food from abroad can never be tolerated in a country where multitudes of the population, even at present prices, can scarcely earn a sufficiency of the common necessities of life. We must therefore endeavour to secure larger returns from our own soil, so

as to conciliate the apparently conflicting interests of the country and the town, of the farmer and the artisan. How to effect this desirable consummation is the object of M. Ville's teachings. Taking his stand upon practical experiments conducted in numerous places, he declares that the European farmer need not fear American competition if he will give his crops plant food of the right kind, and in the right quantity in the form of chemical manures. If this is done, he shows by successful trials that wheat can be produced at a lower cost, that the area of land at present devoted to grazing may be lessened without decreasing the supply of meat and dairy produce, and that the whole population, and consequently the country, may be more prosperous. In England we have come to a very different conclusion. Some of the oracles of the day advise the farmer to cease cultivating the land and to lay it down to "permanent pasture!" It must of course be admitted that in England we encounter certain disadvantages from which France is comparatively free. We enjoy less often a warm and dry summer. We have allowed the beds of our rivers to become silted up with refuse, so that a slightly increased rainfall sends their waters out over the adjoining lands in a destructive flood. But in spite of all these disadvantages, a practical farmer, whose pamphlet we had the pleasure of reviewing not very long ago, has shown us that wheat can be, and has been, grown at a profit, even during the last unfavourable years. On the other hand, Mr. W. A. Gibbs has taught us how both hay and grain may be securely harvested in wet seasons. So that there is no occasion to say that the teachings of M. Ville can have for us especial interest. We can grow grain at a profit if we will only use the methods which Science offers to our hands. The author recommends chemical manures in preference to farmyard manure for several reasons. In the first place the former is the cheaper. The active principles in a dung-heap cost more per pound than do the same principles applied in the form of phosphate of lime, of Stassfurt salts, and of sulphate of ammonia or of Chilian saltpetre. This may perhaps astonish certain farmers of the old jog-trot school, who by dint of bad book-keeping, or sometimes by keeping no books at all, have come to the conclusion that farmyard manure costs little or nothing. Whence comes the fertilising matter contained in the dung of animals? An ox or a sheep cannot create nitrogen, phosphorus, or potash. All of these substances, which are to be found in its liquid and solid excrements, have been derived from its food. That food has been grown upon the farm. Now if we could restore to a plot of say 100 acres the excreta of all the animals, human or brute, which have been fed upon the produce of the same hundred acres, we should certainly keep up the fertility of this plot of land, though we could never increase it. But this complete restoration to the soil of all that has been taken from it is impossible. Cattle and wheat have been grown, and are eaten in our towns in the forms of meat and bread. But the excrements of the persons consuming them do not find their way back to the farm. They pass into the sewers, are there diluted with an excess of water, and after duly polluting our rivers, pass out to sea. It is therefore utterly idle to think that we can keep up the fertility of our land by merely returning to it about one-half of what has been taken from it. Yet this is what is practically hoped for by those who think that the fertility of a farm can be permanently kept up by means of farmyard manure alone.

Chemical manures have a further advantage beside that of cheapness. They can be varied in their quality just as is required by the wants of each crop and each soil. All these points M. Ville enforces clearly, illustrating his doctrines by actual experience. He does not proscribe farmyard manure. He protests merely against its being made the exclusive stay of the farmer, and shows how it may be adapted for particular purposes by the addition of the necessary chemicals.

So far, perhaps, the teachings of the author differ little from those of the majority of chemists who have made agri-

culture their especial study. But on certain important points he stands almost alone. It is generally supposed that plants derive their nitrogen from the soil and from the manure added or from ammonia and oxides of nitrogen present in the air. M. Ville, on the other hand, contends that certain plants, e.g., peas, beans, clover, and lucern, are able to absorb and assimilate the free nitrogen of the atmosphere, and consequently do not require, and are not benefitted by, nitrogenous manures. Hence he further argues than an arable soil may be preserved in full fertility if we restore to it year by year one-half of the weight of nitrogen which has been removed by the crops. It must here be admitted that the full weight of experimental evidence is against M. Ville. Not a few skilful chemists have studied this point. Seeds have been sown in soils containing every requisite of plant-growth save nitrogen. They have been exposed to air from which all ammonia, ammoniacal salts, and nitrogen oxides had been carefully removed. But on analysing the crop no excess of nitrogen was found over and above that present in the seed. These experiments have been multiplied and repeated under different conditions, such as degrees of heat, moisture, speed of current of air to which the plants are exposed, but the results have been negative. The cultivation experiments of M. Ville as recorded seem indeed to support his theory, seeing that nitrogenous manures have in his hands proved themselves useless as applied to the crops above mentioned. On the other hand, Dr. Lawes finds that red clover, if cultivated year by year in a given plot of soil without the addition of any nitrogenous manure, does exhaust the soil of nitrogen. Or, to speak more guardedly, the nitrogen in the soil decreases when no plant save red clover has access to it.

Another peculiarity in the views of M. Ville is the exclusive weight he lays upon three mineral constituents—phosphoric acid, potash, and lime. He does not deny that the other mineral elements found in the ash of plants are necessary to their vigorous growth, but he considers that with all, save phosphoric acid, potash, and lime, "even the poorest soils are sufficiently supplied." Hence in all his formulæ for manures lime is invariably present in the form of gypsum, whilst magnesia is as invariably absent.

It is right here to admit that the universal applicability of gypsum—and, indeed, the general necessity for lime—is not confirmed by English experimentalists. So far from it, that a method for preparing soluble phosphate without the simultaneous production of gypsum is desired by many. M. Ville's experiments generally show a somewhat better result when his complete manure—ammonium sulphate, superphosphate, potassium sulphate, and gypsum—is used than when the gypsum ingredient is left out. But it must not be forgotten that in this latter case he uses dicalcic phosphate instead of the ordinary soluble phosphate,—a change which may easily produce a difference independent of the presence or absence of gypsum.

An exceedingly important point in M. Ville's treatise is his advice to decide on the capabilities and requirements of land by means of trial plots, one, e.g., to be treated with farmyard manure in known proportion, a second with the complete or normal manure, others with manures each deficient in some one of his four leading principles, nitrogen, phosphate, potash, and lime, whilst a last plot is left unmanured. He throws out the suggestion that trial-plots on a small scale should be attached to elementary schools in rural districts, so that boys may be early impressed with the leading conditions of plant life.

Setting aside certain ideas which are at present not proven, M. Ville's work is of great value to all interested in agriculture, and deserves a careful, and wherever possible an experimental, study.

Deodorisation of Musk.—W. Wiesenthal.—A solution of quinine hydrochlorate in water acidulated with hydrochloric acid, entirely and quickly removes the odour of musk from any object.—*Chemiker Zeitung*.

CORRESPONDENCE.

THE ACTION OF WATER ON LEAD.

To the Editor of the Chemical News.

SIR,—In reading Mr. Allen's paper (CHEMICAL NEWS, vol. xlv., p. 145), and arguing from the experimental results he published, I was led to a completely opposite conclusion to that which he attains, namely, that the presence of a trace of free sulphuric acid is advantageous in the case of soft waters coming in contact with lead pipes. The deductions and conclusions which led me to this result were as follows:—

That free sulphuric acid acts upon metallic lead:

That the amount of lead dissolved by sulphuric acid present in waters advances with the amount of acid added, but that the proportion of lead dissolved as compared with the amount of lead which the added acid is capable theoretically of dissolving advances at a much greater rate than the amount of acid added.

Thus, with regard to the experiments with natural Sheffield waters in which was a known quantity of acid, we find that in No. III. there were added 1.12 grains of free sulphuric acid per gallon. Now the amount of metallic lead which Mr. Allen finds to have been taken up into solution by this acid is 0.28 grain per gallon, whereas, theoretically, it should dissolve if the acid were saturated 2.898 grains; that is to say, that the acid took up just one-tenth of the theoretical amount. In the same way, in experiment No. IV., the acid added was 5.6 grains per gallon, the lead actually taken up was 4.9 grains per gallon, while the theoretical amount is 14.49; that is, the acid took up rather more than one-third of the theoretical amount.

From these two experiments, and also approximately from No. II., although the quantities are not given sufficiently exactly to form any accurate deduction, yet, speaking generally, it appears:—

I. That at least from 0.112 to 5.6 grains per gallon the greater the amount of acid added the greater is the amount of lead dissolved, and this is the conclusion Mr. Allen has drawn. But at the same time it also appears—

II. That even when the water has taken up the maximum amount of lead sulphate it can hold in solution the action of the acid will still continue, the extra sulphate being presumably in the state of suspension. And lastly—

III. That the less acid there is present the smaller fraction of that acid will be saturated in a given time.

Thus in No. III. the proportion saturated = $\frac{1}{10}$.

In No. IV. the proportion saturated = $\frac{1}{3}$.

The apparent anomaly in this third deduction may, I imagine, be partly explained in the case of lead pipes by considering that when a strongly acid water comes in contact with the lead a strong solution of lead salt is formed along the line of contact, and this solution, on account of its difference of density, sets up a current, thus continually enabling fresh acid to come into contact with the lead. This action being of course proportional to the strength of the acid, it follows that a stronger solution of acid—between the limits laid down—would have a greater fraction of its acid saturated with lead in a given time. In the case of leaden plates such as Mr. Allen used in his experiments, this action is probably accounted for by the different rates of diffusion, when the greater the difference in density between the two liquids the higher will be the rate of diffusion, from which the same conclusions may be drawn as in the case of the action on lead pipes. Therefore—within the limits prescribed—the less the amount of free sulphuric acid present in the water the less proportion of that acid is likely to be saturated with lead in a given time; and, conversely, the larger proportion of it will remain free, in the presence of which free acid neither the carbonate nor the oxide of lead can exist, and it is only by such prolonged contact that the whole of the free sulphuric

acid becomes saturated—and Mr. Allen's experiments clearly prove that this is a long process—that any carbonate or oxide of lead can enter into solution.

Supposing, on the other hand, this natural soft water to be either neutral or alkaline, the action will be presumably as follows:—The oxide will in the first place be formed, and this being acted on by the available carbonic acid in the water, will be instantly converted into the almost insoluble neutral carbonate, which in the presence of excess of oxide of lead will become the all but absolutely insoluble basic carbonate of lead. This will immediately fall out of solution as such, leaving the water deprived of its carbonic acid and free to act in conjunction with its free oxygen on the metallic lead, thus forming the oxide, comparatively speaking, so extremely soluble.

This explanation is borne out by Mr. Allen's experiment with distilled water No. I., when he finds it to have taken up 7 grains of lead per gallon. Of the state in which these 7 grains of lead exist in the water apparently two views may be taken. First, that as Mr. Allen seems inclined to suppose, a considerable portion, say the whole, of the lead is in suspension as basic carbonate, which points to a very rapid action of this acid on lead; or, second, that only a portion of the lead is in suspension as carbonate, the remainder being present in solution as oxide, which view indicates that carbonic acid in water becomes rapidly saturated with lead, the water itself then proceeding to attack the lead by forming oxide, while, on the other hand, in the same time sulphuric acid taking even in the case of so large a quantity as 5.6 grains of free SO_3 per gallon is only able to become one-third saturated, and in smaller quantities not one-tenth.

From these considerations, then, it appears that sulphuric acid in minute traces prevents the action of soft waters from becoming so rapid as it would otherwise become if it were neutral or alkaline, which view is further supported by Mr. Allen's experiment No. I. with the natural Sheffield water, whose action he shows to have been so slow, as he states that this water was *slightly acid* rather than neutral. In fact the only experiment which Mr. Allen has made, which on the face of it appears to contradict this view of the case, is No. II. of the series made with distilled water, when it appears that 0.112 grains of free sulphuric acid were saturated with lead, and a further large quantity was taken up, as Mr. Allen states, in the form of suspended carbonate. But this also will go to confirm the view I uphold when it is remembered that, firstly, it is not a natural water and contains no salts in solution, which salts may very possibly retard the action of the free SO_3 —and apparently do so judging from the experiments with natural waters; and, secondly, that this amount—0.112 grain of acid per gallon—may possibly fall below the amount with which this law holds good, as in experiment No. II. with natural waters, although only 0.112 grain of free acid were added, yet the water itself was previously acid.

Further, in considering the relative physiological effect of the carbonate and the sulphate of lead, the carbonate appears to be infinitely the more poisonous of the two, as it is very readily converted into extremely soluble salts by the action of the acids of the stomach. Thus, again, from this point of view it will appear preferable for the lead to exist as sulphate rather than as carbonate.

There is one other class of waters whose action on lead pipes it would be perhaps well to consider at this point, namely, hard waters. In this class of natural waters, as is well known, carbonate of lime exists in considerable quantities held in solution in the water by carbonic acid as calcic bicarbonate. This solution, then, of the bicarbonate coming in contact with the solution of oxide of lead formed by the joint action of the water and its free oxygen immediately forms a precipitate consisting of carbonates of lime and lead. From the very large amount of carbonic acid present in this available form, as also by the production of a double precipitate, it may be easily seen that it will be so copious as to rapidly coat the pipes, and

hus preserve them from further action. The large amount of salts in solution in this class of waters may also exercise a great effect in preventing the solution of any lead.

Lastly, the remarks which Mr. Allen makes on the question as to whether the free acid actually exists in the water in the state of sulphuric or hydrochloric acid appear to me to fall somewhat outside the enquiry, for he apparently admits that the prime origin of the free acid was the decomposition of iron sulphate into a basic salt with either the liberation of free acid or an acid salt, which acid he then considers to act on the metallic chlorides present in the water, thus liberating free hydrochloric. This may occur, but it must be borne in mind that the amount of lead dissolved by this free hydrochloric can be no more than an exact equivalent of the amount which the free sulphuric acid is capable of taking up; and, moreover, that (arguing in the same line which Mr. Allen adopts) this lead chloride is no sooner formed than it is converted into lead sulphate by the metallic sulphates. As to whether either the one or the other of these reactions *would* take place in solutions so dilute is a matter of speculation; but it will, however, be seen that, provided the original acid is sulphuric, it can have little to do with its power of taking up a definite quantity of lead, whether it sets free its equivalent of hydrochloric from chlorides present, or whether it acts directly on the lead itself.

The above deductions, based on Mr. Allen's experiments, appear to me to abundantly prove, and fully bear out, the contention of Dr. Tidy, Prof. Odling, and Mr. Crookes, that a trace of free sulphuric acid is advantageous in a soft moorland water, when its action on leaden pipes is considered.—I am, &c.,

ARNOLD PHILIP, A.R.S.M.

45, Tyrwhitt Road, St. John's, London,
September 6th, 1882.

IMPORTING ATMOSPHERIC AIR.

To the Editor of the Chemical News.

SIR,—Being a subscriber to your valuable paper, I read first only those articles relating to the business in which I am at present engaged (steel and iron). For this reason I was not aware until to-day of the little incident credited to Von Humboldt and Gay-Lussac (CHEMICAL NEWS, vol. xlv., p. 100).

Permit me to relate an occurrence that took place in the year 1867. In that year I was a student of the celebrated chemist Prof. Wurtz, at l'Ecole des Medicines à Paris. There were perhaps fifteen others studying at that time.

One of the students used a new French glass tube in making a combustion, claiming that it was superior to the Bohemian. Needing some glass tubes for my own use, I thought the best way to settle the dispute would be to try the Bohemian glass with the French. So I requested Dr. J. Bettendorf, of Bonn, to buy some Bohemian tubes for me. I asked him to cut them in two pieces, and melt the ends in a point, and to number the pieces and label them "Deutsche Luft." I did this to avoid trouble with the Custom-House officers.

There was no duty on articles used for scientific purposes, but it was sometimes very difficult to convince the Custom authorities that certain articles were intended for the uses of Science.

When the articles arrived I called at the Custom-House and paid the two francs, which the officer with a piercing smile demanded, feeling that I had paid the cent for tribute, while I was willing to spend in the defence of my rights millions,—if I had had them only!

Part of the tubes I divided among some of the students of Prof. Wurtz, and the balance I brought back to Germany with me. MM. Voigt and Gauthier, and perhaps M. Wurtz, will remember the occurrence.

Now, Sir, if the correspondent of the Berlin paper is sure that Alexander von Humboldt and Gay-Lussac did

exactly the same harmless trick that I did, then really will I believe the old proverb "Nil novi sub sole."—I am, &c.,

HUGO BLANCK,
Chemist with Spring, Steel and Iron Co.,
Etna, Pa.

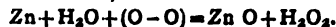
Sharpburg, Pa.,
September 17th, 1882.

FORMATION OF OZONE.

To the Editor of the Chemical News.

SIR,—In reference to Mr. Kingzett's paper, which appeared in your last number, allow me to state that on presenting my views regarding the formation of ozone when phosphorus undergoes slow oxidation in a moist atmosphere, I did not think it necessary to introduce water into my equations as this would have in no way added to the clearness of the reactions, the only change which water undergoes being its combination with phosphorus pentoxide to form phosphoric acid, thus putting it out of the influence of further change, owing to the comparatively great stability of the latter compound.

Had pentoxide of phosphorus been an insoluble compound then I would have been obliged to take water into account, as in that case hydrogen dioxide would have been formed, and not ozone, thus:—



In the oxidation of phosphorus, hydrogen dioxide can result only in the presence of an excess of moisture, and then only in small quantity, as it is immediately decomposed by the ozone into water and oxygen, thus:—



R. LAMONT.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcvi., No. 12, September 18, 1882.

Miasmatic Fevers.—M. d'Abbadie.—The author mentions that certain elephant hunters who frequent miasmatic districts of the Soudan, as a preservative, expose themselves daily to a fumigation with sulphur. The town of Zephyria, in the island of Milo, was populous as long as sulphur mines were worked in its immediate neighbourhood, but became deserted on the removal of this industry to the opposite side of the island. The desertion of the town was owing to the severe malarious fevers which became common. [If sulphur fumes are a prophylactic against zymotic disease it is possible that the coal smoke of England may have a certain sanitary value.]

Separation of Gallium.—Lecoq de Boisbaudran.—(See page 165.)

The Influence of Temperature on the Spectra of the Non-Metals.—D. Van Monckhoven.—The author has proved by numerous experiments that the so-called "high temperature spectra" of the non-metals can be produced at very low temperatures and *vice versa*. He takes a tube with four electrodes in the form of H, and filled with nitrogen, oxygen, or one of the gases or vapours giving two spectra; into this tube he causes to pass at the same time the currents of two induction-coils, the one with the interposition of a Leyden jar. Two superposed spectra are observed; the spectrum attributed to high temperatures (Leyden jar) and the spectrum of low temperatures (ordinary spark). In accordance with Plücker's hypothesis the gas should therefore have at the same

moment two distinct temperatures, which is inadmissible. The author ascribes the change of the spectra emitted by the non-metals to a peculiar vibratory state of their molecules, depending directly on the nature of the electricity employed.

The Action of Presence of Leaves of Zinc in Boilers, and a Process for avoiding Explosions.—M. Trève.—The author finds that a battery is formed by the iron and the zinc, which occasions a continuous decomposition of water. The oxygen combines with the zinc, and the zinc oxide combines with the fatty acids present in the feed-water, forming a zinc soap, which prevents the adhesion of saline matter to the sides and plates of the boiler. The hydrogen prevents the danger of explosion from the absence of gaseous matter, and consequent superheating. When a boiler has been kept for a considerable time with its fire banked up, the hot water is totally deprived of air, and on then raising the heat an explosion is possible. In such cases he recommends that a part of the water should be run off, and fresh water containing air introduced in its stead.]

Justus Liebig's Annalen der Chemie,
Band 213, Heft 3.

Influence of Mass upon Chemical Transformations.—James Morris.—In the first section of this dissertation the author has studied the action of barium chloride upon mixtures of potassium chromate and carbonate in aqueous solution. In the second section he examines in like manner the action of barium chloride upon mixtures of potassium sulphate and carbonate, also in aqueous solution. The results of the investigation are that in the reaction the mass relations of the potassium salts employed are decisive, both salts giving up so much of their acid to the precipitate that the proportion of the residual salts in the filtrate may be expressed by numbers which are almost constant. The changes in the composition of the precipitates proceed not *per saltum*, but continuously. A given addition of carbonate increases the carbonic acid in the precipitate, first slowly, then rapidly, and at last slowly again. In the simultaneous action of chromic acid and carbonic acid, the latter possesses at a boiling heat a much greater efficacy than at common temperatures, whilst in case of sulphuric and carbonic acids this property is less conspicuous. Whether an equal quantity of liquid is employed or not, has no marked influence upon the final product so long as the mass-relations of the salts employed remain the same.

Researches on Uranium.—Clemens Zimmermann.—The author's main object has been to test the assumption of Mendelejeff that the atomic weight of uranium should be doubled, and be taken in round numbers as 240. This question he decides in the affirmative. Among his chief results are the following: Uranyl salts in sulphuric solution are reduced by zinc only to urano-salts, which can be most accurately determined by means of permanganate solution. Uranyl salts are converted by zinc and hydrochloric acid into an uranium sub-chloride, U_2Cl_6 . It is distinguished by instability, and is identical with Peligot's sub chloride. The volumetric method of Margueritte, which depends on the oxidising action of permanganate, is not adapted for the determination of metallic salts in hydrochloric solution. A simple modification renders it very accurate in such cases, and opens up a wide field for the examination of the reduction-products of many metallic oxides. This modification is as follows: If to a solution of ferrous chloride containing hydrochloric acid there is added a manganous salt (sulphate or chloride), and it is then titrated with a permanganate solution of known strength, not the slightest odour of chlorine is perceptible, and the number of c.c. of the standard solution required for oxidising the ferrous salt corresponds exactly to the calculated number. The author prefers manganous sulphate and prepares the solution by dissolving 100 grms. of

the salt in water, and diluting to about 500 c.c.; 20 c.c. of this solution are sufficient to render the titration of ferrous salts with permanganate absolutely accurate, even in presence of 50 c.c. free hydrochloric acid. A further result is that the sub-uranous oxides of Guyard are non-existent. The uranous and sub-uranous salts are distinguished by very characteristic absorption-spectra. This reaction of the uranous salts is not in the least interfered with by the presence of compounds of chromium iron, zinc, nickel, &c. 20 c.c. of a solution of uranyl sulphate, containing 0.01569 gm. UO_3 per c.c., were heated in a small flask with zinc and 20 c.c. dilute sulphuric acid till the green colour of the solution shows a complete reduction to uranous sulphate. If, during this process, the solution is observed with the spectroscopic, there appears first a narrow absorption-band in the greenish yellow, which is quickly followed by others in the red, blue, and violet.

Non-Existence of Pentathionic Acid.—W. Spring.—The author concludes that the existence of pentathionic acid is not proved.

Determination and Separation of Antimony and Tin.—Dr. A. Weller.—Antimonic acid and antimonious oxide, and in like manner antimony penta- and tri-chloride, can be most easily distinguished from each other by their different behaviour with potassium iodide. The property of the former when in hydrochloric solution of separating two atoms iodine from potassium iodide for each atom of antimony can be used for the quantitative determination of antimony. In order to verify the method, weighed quantities of finely-pulverised pure metallic antimony were oxidised in a flask at a gentle heat with potassium chlorate and hydrochloric acid, and the excess of chlorine was expelled by strong heating. The solution of antimony penta-chloride thus obtained was introduced into the flask of Bunsen's chlorine distillation apparatus by means of hydrochloric water, considerably diluted, and mixed with a sufficiency of perfectly pure potassium iodide, avoiding too great an excess. The liberated iodine was distilled into dilute solution of potassium iodide, observing all the precautions laid down by Bunsen, and especially cooling the retort well in flowing water. When cold the distillate is titrated in the usual manner by means of very dilute sulphurous acid and an iodine solution of known strength. The distillation flask has the capacity of about 120 c.c. The distillation requires from five to ten minutes. Particularly important is the fact that stannic acid and stannic chloride in acid solutions do not decompose potassium iodide. This behaviour renders it possible to determine antimony in presence of tin, as in alloys, easily and accurately. The tin is calculated as difference.

Communications from the Chemical Laboratory of the University of Graz.—These consist of the continuation of a memoir by Karl Garzarolli-Thurnlackh on the action of zinc ethyl and zinc methyl upon chlorinised aldehydes.

Journal für Praktische Chemie.
New Series. Vol. xxv., No. 11.

Certain Derivatives of Isophthalic Acid.—Dr. Bruno Beyer.—The author gives an account of isophthalic acid, γ -mono-nitro-isophthalic acid and its salts, and its ethyl and methyl ethers, γ -mono-amido-isophthalic acid, its salts and ethers; γ -diazo-isophthalic acid, γ -mono-chlor-isophthalic acid, its salts and ethyl-ether, and γ -mono-oxy-isophthalic acid. The principal results are that the mono-nitro-isophthalic acid produced by treating isophthalic acid with fuming nitric acid, belongs to the so-called γ -series, as is shown by its conversion into the oxy-acid of that series. This mono-nitro-isophthalic acid (melting-point 249°) crystallises with 14 mols. water, dissolves in 685 parts water at 15° , and in 1.23 parts at 99° . Its methyl-ether melts at 121.5° , and its ethyl-ether

at 83.5°. The γ -mono-amido-isophthalic acid crystallises with 2 mols. water; its aqueous solution is coloured an intense reddish brown by ferric chloride. It dissolves in 962 parts of water at 15°, and in 103.2 parts at 99°. Its ethyl-ether melts at 118°, and its methyl-ether at 176°. By the action of nitrous acid in the cold, the amido-acid passes into a well characterised diazo-compound, which yields γ -oxy-isophthalic acid on decomposition with water.

The Solutions which Salicylic Acid forms with Water.—Wladimisi Alexeew.—At temperatures between 63° and 90.5° salicylic acid and water form three kinds of solutions. 1. Solution of water in salicylic acid; 2. Solution of salicylic acid in water, which on cooling deposits the liquid acid; 3. Solution of salicylic acid in water, which on cooling deposits the acid in crystals. The two latter are isomeric.

Worthiness and Appreciation: Reply to the Attack of H. E. Drechsel.—J. L. W. Thudichum.—Not capable of useful abstraction.

Two Anhydrides of Para-oxy-benzoic Acid.—A. Klepl.—If para-oxy-benzoic acid is distilled at a moderate heat, and if the process is interrupted as soon as the residues solidifies, there remains a mixture of two anhydrides of the acid, which can be separated by boiling in absolute alcohol, in which the more abundant is insoluble. The author is engaged with the examination of these bodies.

A Solution of Anhydrous Copper Sulphate in Methyl Alcohol.—A. Klepl.—Absolute methyl alcohol dissolves the amorphous anhydrous sulphate, but not that which is rendered crystalline by taking up water. Ethyl alcohol does not possess this property.

Isomerism of Cuprous Sulphite.—M. Etard.—From the *Comptes Rendus*.

MISCELLANEOUS.

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* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Crude Naphtha.—In testing this up to 120° C. and then letting down the heat to about 90° C. and again distilling up to 120° C., I find there is an additional yield of about 13 per cent or so. Is this usual, or merely the result of unskilful manipulation?—CARBON.

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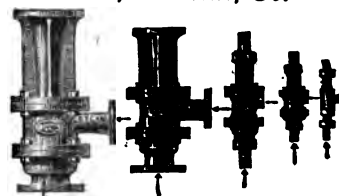
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THE CHEMICAL NEWS.

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ESTIMATION OF DEXTROSE, MALTOSE, AND DEXTRIN IN AMYLOSE (STARCH SUGAR).

By HARVEY W. WILBY,
Lafayette, Indiana.

In a paper read at the Cincinnati Meeting of the American Association for the Advancement of Science,* I gave a brief outline of some of the more important methods which have been proposed for the analysis of amylose.

In closing that paper I said:—"From a very extended series of analyses I will say that there is no method known which will give reliable numbers for the percentage of the different constituents. I propose to attempt the accomplishment of this very desirable result by first polarising the solution, treating it with a reducible reagent, and repolarising the residue."

Since that time I have succeeded in carrying out this plan with results which are sufficiently satisfactory to justify me in making them public.

Samples.

The amyloses which I have used were those of commerce, and were manufactured in widely separated localities. They were subjected to no process of purification, and were obtained in the open market and from the manufacturers. They were such as are usually employed in the adulteration of sugars and syrups.

The Process.

(1.) Ten grammes of the samples, undried, were dissolved in water, the volume made up to 1000 c.c., and used for the reduction of the standard Fehling's solution.

(2.) Ten grammes were dissolved in water, made up to 100 c.c., and polarised in 200 m.m. tube.†

(3.) Ten c.c. of (2) were treated with an excess of the mercuric cyanide solution (described further on) and boiled. Hydrochloric acid (strong) was then added in slight excess, and, after cooling, the volume made up to 50 c.c.

(4.) The above was next polarised in a 500 m.m. tube, and the angular rotation multiplied by two.

Theory of the Process.

(1.) The first reduction of Fehling's solution gives the total percentage of reducing matter, viz., dextrose with a reducing value of 100, and maltose with a like value of 62.

(2.) The first polarisation gives the apparent specific rotatory power due to all the optically active bodies present, viz., dextrose = 52, maltose = 139, and dextrin = 193.

(3.) The second reduction (by mercuric cyanide) leaves in the solution as optically active the dextrin alone.

(4.) The second polarisation gives the rotatory power of dextrine only.

With these points determined, all the data necessary to the calculation of the percentages of the three substances are at hand.

The Manipulation.

(1.) It is not advisable to take more than 10 g. in 1000 c.c. for treatment with the copper solution. From 10 to 20 c.c. of this will reduce 10 c.c. of the copper.

* *Science*, vol. ii., No. 66, pp. 464-466.

† To save one weighing the solution (2) was first made, and 10 c.c. of it made up to 100 c.c. for No (1).

The end of the reaction I determine, in all cases, by filtering a drop or two into a white dish containing a little solution of ferrocyanide of potassium and acetic acid. Three closely agreeing determinations are made, and the mean of these taken as the correct result.

(2.) In polarisation I find 10 g. in 100 c.c. to be a convenient quantity. If a solid amylose is to be examined the solution must be heated to 100° for some time to destroy bi-rotation. For my optical work I use the large *pénombre* instrument made by Laurent, which has been adopted for use in all the sugar work done by the French Government.

(3.) A convenient strength for the mercuric cyanide solution is 120 g. $\text{Hg}(\text{CN})_2$, and the same amount of stick NaOH per litre. It is not necessary to standardise the solution. If a precipitate is formed in mixing the cyanide solution with the alkali, filter through asbestos before using. 20 c.c. of the solution will be found sufficient for amyloses with less than 65 per cent reducing matter. When more than this is present use 25 c.c.

In all cases a slight excess of cyanide must be used. Test by holding filtering paper with a little of the solution on it over fuming HCl , and afterwards over ammonium sulphide. A 50 c.c. graduated flask is used. In boiling care must be taken that the liquid is not thrown out. Two or three minutes boiling will be found sufficient. On application of heat the liquid turns reddish brown. When HCl is added this colouration disappears. In no case have I found it necessary to use animal char or lead acetate to fit the liquid for the observation tube. Since the volume of the liquid has been increased during the process from 10 to 50 c.c., and the tube of observation is only two-and-a-half times as long as the first one, it becomes necessary to multiply the reading of the instrument by two in order to subject it to the same conditions as the first polarisation. This gives the polarisation due to dextrin alone.

Calculations.

(1.) The first reduction gives the reducing per cent of the dextrose d + that of the maltose m . Since maltose, however, has a reducing power as compared with dextrose of only 0.62; we have the equation—

$$R = d + 0.62 m \quad (1)$$

(2.) The first polarisation gives the rotation due to the dextrose, maltose, and dextrin. From this the apparent specific rotatory power is easily calculated.* This gives the equation—

$$P = 52 d + 139 m + 193 d' \quad (2).$$

(3.) The second polarisation gives the dextrin rotation power, and is expressed—

$$P' = 193 d' \quad (3),$$

from which the value of d' is easily calculated.

(4.) To find d and m : subtract equation (3) from (2). This gives—

$$P - P' = 52 d + 139 m \quad (4).$$

Multiply (1) by 52, and subtract from (4).

$$P - P' - 52R = 106.76 m \quad (5).$$

Whence—

$$m = P - P' - 52 R \div 106.76 \quad (6)$$

and

$$d = R - 0.62 m \quad (7)$$

and

$$d' = P' \div 193 \quad (8)$$

Illustration.

Sample of solid amylose made by Peoria Grape Sugar Company.

10 g. in 100 c.c. polarised 21.29° . Whence $P = 106.45$. Percentage of reducing matter $R = 40.32$.

Polarised after treatment with $\text{Hg}(\text{CN})_2$, 13.4° . Whence $P' = 67$.

Substituting these values in the several equations—

* *Proceedings A.A.A.S.*, Boston Meeting, 1880, p. 309.

TABLE I

	I	II	III	IV	V	VI	VII
Percent dextrose	24.51	74.48	71.40	64.07	65.15	33.36	30.41
Percent maltose	17.28	2.49	2.32	4.20	3.30	7.26	1.79
Percent dextrin	34.72	3.53	2.69	6.11	6.20	45.24	32.75

Percent dextrose, maltose, and dextrin determined by the method of Allen, in the form of the following:

Let R, T, and P represent the amounts of reducing matter, total solids, and specific rotatory power respectively. Then—
 $m = P - [(T - R) 193 + 52 R] \div 33.42$

TABLE II

	I	II	III	IV	V	VI	VII
Percent dextrose	24.51	74.48	71.40	64.07	65.15	33.36	30.41
Percent maltose	17.28	2.49	2.32	4.20	3.30	7.26	1.79
Percent dextrin	34.72	3.53	2.69	6.11	6.20	45.24	32.75

TABLE III

	I	II	III	IV	V	VI	VII
Dextrose	24.51	74.48	71.40	64.07	65.15	33.36	30.41
Maltose	17.28	2.49	2.32	4.20	3.30	7.26	1.79
Dextrin	34.72	3.53	2.69	6.11	6.20	45.24	32.75

- (1) $11.4134 - 4.4162 m$
- (2) $11.4134 - 52.4 + 193 m + 193 d$
- (3) $67.193 d$
- (4) $59.43 - 52.4 + 193 m$
- (5) $11.4134 - 67.193 + 52.4 + 193 m$
- (6) $m = 11.4134 - 17.31 \text{ per cent}$
- (7) $d = 11.4134 - 29.91$
- (8) $d' = 11.4134 - 34.72$
- (9) $m, d, \text{ and } d' = 11.4134$
- (10) Water = 16.26
- (11) Ash = 0.19
- (12) Hum = 0.07
- (13) Inactive = 1.93

Table I shows the numbers obtained in seven analyses of different samples. These samples show the widest differences in composition from an extremely low conversion like *confectioners' glucose*, No. 6, to a very high conversion like No. 2.

Calculations from the above data give the percentages shown in Table II, of dextrose, maltose, and dextrin. The result in No. 6 is a remarkable one. The sum of the three per cents, plus H_2O , is more than 100. This doubtless arises from the presence of a variety of dextrin or soluble starch with a rotatory power different from 193. If the percentages of dextrose, maltose, and dextrin are calculated from the specific gravity of the solution,* the most contradictory results are obtained. In most cases the percentage of maltose becomes a negative quantity of considerable magnitude, and the other percentages are in considerable distortion. This method, which heretofore has been regarded as the best one, is valueless for showing the actual composition of the starch sugars of commerce. Even if no other solids were present in the solution except the three in question, a slight error in specific gravity determination would make a wide difference in the results. But the amount of other solids, optically inactive, a commercial starch sugar may be (as shown) to per cent.

For convenience I have placed the method of calculation, as given by Allen, in the form of the following

Rule

Multiply the percentage of reducing matter in sample by 52. Subtract per cent reducing matter from total solids (determined from sp. gr.), less ash, and multiply remainder by 193. Take the sum of the two products, and subtract from apparent sp. rotatory power. Divide the remainder by 33.42, and multiply by 100 for per cent of maltose.* Multiply per cent maltose by 0.62, and subtract from reducing power for per cent dextrose. Find dextrin by difference.

If the sum of the optically active solids determined in the direct way is taken as a basis of calculation, and the above rule applied, it will afford a check on the direct method, which will prove a valuable aid in reaching reliable results.

In Table III. are shown the results obtained by this method compared with those given by direct determination.

The numbers show that the method of direct determination is practically reliable. For if the results it gives were far from the truth, the theoretical calculations founded thereon would vary widely from the numbers obtained. Except in No. 2, however, this disagreement does not occur.

In No. 2 the variation is too great to pass unnoticed. In such a case the error is probably some fault of the first determination. Where the variation is as great as in No. 2 a new analysis should be made.

I do not know any method for determining such bodies as soluble starch, or varieties of dextrin as such.

Enough has been given to show that the method of direct determination by double reduction and polarization is the only reliable one for estimating dextrose, maltose, and dextrin in commercial amyloses, where these, as is generally the case, are the only optically active bodies

* Let R, T, and P represent the amounts of reducing matter, total solids, and specific rotatory power respectively. Then—
 $m = P - [(T - R) 193 + 52 R] \div 33.42$

present in any notable quantity. Practically the process will prove of great benefit to starch-sugar manufacturers, brewers, and distillers, and in all other cases where the exact constitution of these sugars is an important factor in their value.

The numbers given by this new process will vary with the numbers which represent the specific rotatory of the several substances to be determined, and also with the number which expresses the relative reducing power of maltose. If any or all of these numbers should undergo revision, it would only affect the results and not the method employed. It must be also understood that the method itself is based on the assumption that both dextrose and maltose, when treated to saturation with reducible solutions like mercuric cyanide, yield decomposition products which are optically inactive.

My experiments, so far, serve to confirm this assumption, although my inability to procure perfectly pure specimens of dextrin and maltose has prevented me from being able to communicate any definite information at the present time.

I will therefore reserve this part of the subject for a future report.

THE REACTIONS OF THE MEXICAN AMALGAMATION PROCESS.

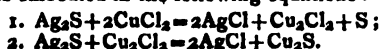
At the suggestion of Dr. Percy, Professor Huntington, of King's College, London, made a series of experiments in 1879, on the reactions in the Mexican amalgamation process. It will be remembered that Dr. Rammelsberg, of Berlin, has also investigated the same subject. The following are some of the main points investigated:—

1. Mercury worked up with sulphide of silver, chloride of sodium, sand, and water, extracted about $\frac{1}{3}$ of the silver present, and three times as much as when chloride of sodium was absent. The presence of oxide of iron causes loss of mercury when the mixture contains chloride of sodium, owing to ferric chloride being formed, which is reduced to ferrous chloride by the mercury, with formation of calomel. A very little oxide of iron has a very marked effect, as the ferrous chloride, as fast as formed, reoxidises, contact with the air, to ferric chloride, and so on.

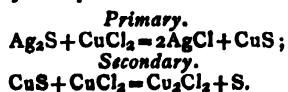
2. When, in addition to the chloride of sodium, the mixture was made up with sulphate of copper, which would produce chloride of copper by double decomposition, rather less silver was obtained, and the loss of mercury was greater. However, on substituting the mineral proustite (silver 65.5, arsenic 15.1, sulphur 19.4) for the artificial sulphide of silver, twice as much silver was extracted by the mercury when the mixture contained chloride of copper. The decomposition of the sulphide of silver is very imperfect, unless the mixture be frequently and thoroughly agitated.

3. Sulphide of zinc, in the presence of cupric chloride, causes the formation of sulphide of copper and chloride of zinc. It is well known that ores containing blende amalgamate badly.

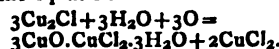
4. A number of experiments were made to establish the action of cupric and cuprous chlorides on sulphide of silver. The generally-accepted explanation of the action of the chloride of copper in the Mexican amalgamation process is embodied in the following equations:—



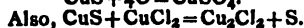
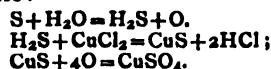
In the experiments made by Professor Huntington, it is shown that the liberation of the sulphur is entirely due to a secondary reaction, which takes place only to a limited extent. It may be represented as follows:—



The secondary reaction takes place *pari passu* with the primary, at the moment double decomposition is occurring between the cupric chloride and the sulphide of silver, and is brought about by the copper of the chloride concerned in the reaction reducing to a lower chloride a further quantity of cupric chloride, in preference to combining with the sulphur of the sulphide of silver; so that, in the result, chloride of silver, cuprous chloride, and free sulphur are produced. The experiments, as a whole, lead to the conclusion that the amount of cuprous chloride formed and sulphur set free is directly dependent on (a) the strength and quantity of a solvent for cuprous chloride present, such as NaCl and CuCl₂, (b) the temperature, (c) the presence of air. The secondary reaction is limited by the power of the solution to dissolve cuprous chloride. Obviously, if the cuprous chloride in solution can by any means be removed, the solvent power of the solution will be to a certain extent renovated. The action of air in facilitating the secondary reaction is therefore due to its converting the cuprous chloride into insoluble oxychloride, according to the equation—



5. In the course of these experiments, it was found that, when sulphide of silver is treated with a strong solution of cupric chloride at a high temperature (boiling), in a stout closed bottle, cuprous chloride and free sulphur are formed in large quantities. If the heating be continued for some time, all the free sulphur disappears, and sulphuric acid is formed. Under similar circumstances, sulphide of copper strongly heated with cupric chloride, air being excluded, yielded sulphate of copper and cuprous chloride, no free sulphur being formed. Sulphur, strongly heated in a hermetically-sealed tube with water, produced sulphuretted hydrogen, but no sulphuric acid. When a 300 per cent solution of cupric chloride was similarly heated with sulphur, cuprous chloride and sulphate of copper were formed. The following equations explain what takes place:—

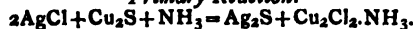


6. The next point investigated was the action of cuprous chloride, dissolved in a solution of chloride of sodium, on sulphide of silver. This is a case of simple double decomposition, represented by the formula—

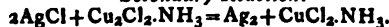


A great many erroneous statements have been made by Malaguti and Durocher, and by others, as to the action of cuprous chlorides on mixtures containing sulphide of silver. They say that silver is liberated in the metallic state. On this supposition they have built up various theories relating to amalgamation processes and to geological phenomena. These errors have arisen through their having employed ammonia as a reagent in the investigation of the action of Cu₂Cl₂ on Ag₂S. Ammonia being a solvent for chloride of silver, they thought that if the latter were formed by the action of cuprous chloride on sulphide of silver, it could be dissolved out from the sulphide of copper by ammonia, and then detected by precipitation in the ordinary way. But when ammonia is added to a mixture of AgCl and Cu₂S, it causes double decomposition to take place, Cu₂Cl₂ being re-formed; and Cu₂Cl₂ + AgCl, in the presence of ammonia, react upon one another with the formation of CuCl₂ and metallic silver. Thus:—

Primary Reaction.



Secondary Reaction.



Though, as a matter of fact, Malaguti and Durocher did not understand the results of their experiments, Rammelsberg's exclamation, "Did the French chemists not know that silver and cupric chloride can not exist together?" is

TABLE I.

	I.	II.	III.	IV.	V.	VI.	VII.
Per cent reducing matter	40.32	76.33	72.83	66.67	67.57	37.88	41.84
Total rotation	21.19°	9.85°	9.11°	10.19°	10.27°	22.95°	20.60°
After treatment with Hg(CN) ₂ ..	13.4°	1.38°	1.04°	2.36°	2.39°	17.46°	12.45°
Due to dextrose and maltose ..	7.89°	8.47°	8.07°	7.83°	7.88°	5.49°	18.15°
Specific gravity 10 g. in 100 c.c. ..	1.030136	—	—	1.03198	1.03107	1.03162	1.02938
Per cent solids from sp. gr.* ..	78.28	—	—	83.07	80.70	82.13	76.57
Per cent solids determined directly and optically active†	81.62	80.85	76.41	74.38	75.25	85.87	80.85
per cent of ash	0.19	0.57	0.23	0.57	0.63	0.33	0.24
per cent of water	16.26	9.43	15.75	16.24	14.94	16.82	18.31

NOTE.—No. 1 from Peoria Grape Sugar Co.; No. 2, Buffalo; No. 3, Freeport, Ill.; Nos. 4 and 5, American Grape Sugar Co., Buffalo; No. 6, ditto; No. 7, Rockford Grape Sugar Co., Rockford, Ill. Nos. 1, 2, 3, 4, and 5 were solids; Nos. 6 and 7 liquids.

* Allen's "Commercial Organic Analysis," vol. ii, p. 296.

† Sum of dextrose, maltose, and dextrin.

TABLE II.

	I.	II.	III.	IV.	V.	VI.	VII.
Per cent dextrose	29.59	74.78	71.40	64.07	65.15	33.38	30.81
Per cent maltose	17.31	2.49	2.32	4.20	3.90	7.26	17.79
Per cent dextrin	34.72	3.58	2.69	6.11	6.20	45.24	32.25

TABLE III.

	I.	II.	III.	IV.	V.	VI.	VII.
Dextrose—Direct	29.59	74.78	71.40	64.07	65.15	33.38	30.81
„ Calculated	29.58	73.41	71.38	64.05	65.01	33.38	30.80
Maltose—Direct	17.31	2.49	2.32	4.20	3.90	7.26	17.79
„ Calculated	17.27	2.20	2.34	4.22	4.13	7.27	17.81
Dextrin—Direct	34.72	3.58	2.69	6.11	6.20	45.24	32.25
„ Calculated	34.70	5.24	2.69	6.11	6.11	45.23	32.24

- (1) $0.4032 = d + 0.62 m$
 - (2) $106.45 = 52 d + 139 m + 193 d'$
 - (3) $67 = 193 d'$
 - (4) $39.45 = 52 d + 139 m$
 - (5) $106.45 - 67 - (52 \times 0.4032) = 106.76 m.$
 - (6) $m = 0.1731 = 17.31 \text{ per cent}$
 - (7) $d = 0.2959 = 29.59 \text{ „}$
 - (8) $d' = 0.3472 = 34.72 \text{ „}$
- Sum of m , d , and $d' = 81.62 \text{ „}$
 Water = 16.26 „
 Ash = 0.19 „
 Sum = 98.07 „
 Inactive = 1.93 „

Table I. shows the numbers obtained in seven analyses of different samples. These samples show the widest differences in composition from an extremely low conversion like confedioners' glucose, No. 6, to a very high conversion like No. 2.

Calculations from the above data give the percentages shown in Table II. of dextrose, maltose, and dextrin.

The result in No. 6 is a remarkable one. The sum of the three per cents, plus H₂O, is more than 100. This doubtless arises from the presence of a variety of dextrin or soluble starch with a rotatory power different from 193. If the percentages of dextrose, maltose, and dextrin are calculated from the specific gravity of the solution,* the most contradictory results are obtained. In most cases the percentage of maltose becomes a negative quantity of considerable magnitude, and the other percentages are in like manner distorted. This method, which heretofore has been regarded as the best one, is valueless for showing the actual composition of the starch sugars of commerce. Even if no other solids were present in the solution except the three in question, a slight error in specific gravity determinations would make a wide difference in the results. But the amount of other solids, optically inactive, present in a commercial starch-sugar may be (as shown) as great as 10 per cent.

For convenience I have placed the method of calculation, as given by Allen, in the form of the following

Rule

Multiply the percentage of reducing matter in sample by 52. Subtract per cent reducing matter from total solids (determined from sp. gr.), less ash, and multiply remainder by 193. Take the sum of the two products, and subtract from apparent sp. rotatory power. Divide the remainder by 33.42, and multiply by 100 for per cent of maltose.* Multiply per cent maltose by 0.62, and subtract from reducing power for per cent dextrose. Find dextrin by difference.

If the sum of the optically active solids determined in the direct way is taken as a basis of calculation, and the above rule applied, it will afford a check on the direct method, which will prove a valuable aid in reaching reliable results.

In Table III. are shown the results obtained by this method compared with those given by direct determination.

The numbers show that the method of direct determination is practically reliable. For if the results it gives were far from the truth, the theoretical calculations founded thereon would vary widely from the numbers obtained. Except in No. 2, however, this disagreement does not occur.

In No. 2 the variation is too great to pass unnoticed. In such a case the error is probably some fault of the first determination. Where the variation is as great as in No. 2 a new analysis should be made.

I do not know any method for determining such bodies as soluble starch, or varieties of dextrin as such.

Enough has been given to show that the method of direct determination by double reduction and polarisation is the only reliable one for estimating dextrose, maltose, and dextrin in commercial amyloses, where these, as is generally the case, are the only optically active bodies

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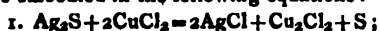
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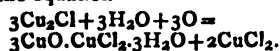
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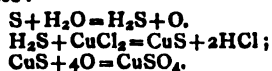
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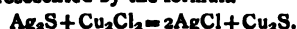
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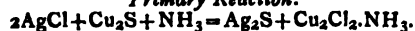


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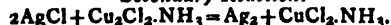


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Though, as a matter of fact, Malaguti and Durocher did not understand the results of their experiments, Rammelberg's exclamation, "Did the French chemists not know that silver and cupric chloride can not exist together?" is

not warranted, as under the conditions just stated they can. It was also found that "reversal" takes place when a mixture of chloride of silver and sulphide of copper is treated with water or chloride of sodium solution. No secondary reaction, liberating silver, however, takes place.

It follows from the foregoing that, in order to bring about double decomposition between sulphide of silver and chloride of copper, the chloride of copper solution must be maintained at a certain strength, otherwise the reaction will cease, and any thing which caused the solution to be still further diluted would undo a proportionate amount of the work already done.

ON THE PROPERTIES OF PURE METALLIC ALUMINUM.

By J. W. MALLET.

In view of the marked effect upon the properties of the individual metals, which is often produced by the presence of even very small quantities of foreign substances, metallic or non-metallic, it is very desirable that when really pure specimens can be had, prepared and tested with unusual care, their properties shall be noted and recorded. Comparatively few of the metals have probably been procured and examined in a state of the highest attainable purity, and comparatively few chemists have learned by personal experience how very difficult it is to get rid of the last detectable traces of foreign matter. This difficulty is especially great in the case of those metals least easily reduced to the metallic state, among which may be counted aluminum.

The writer, having expended much time and labour upon obtaining pure metallic aluminum to be used in his work,* on the atomic weight of this element, succeeded in preparing enough for that purpose, and incidentally noted the following facts in regard to the metal—not forming a complete description of all its properties, physical and chemical—but yet deserving, perhaps, of being placed on record.

The crude (commercial) aluminum, used as the source of the pure metal, was found to contain:

Aluminum (by difference)	96.89
Iron	1.84
Copper	trace
Silicon	1.27

100.00

This was converted into bromide by treatment with liquid bromine, observing the precautions described in the paper (in *Phil. Trans.*) above referred to. A large quantity of the aluminum bromide—more than two kilogrammes altogether—was purified by careful fractional distillation, with due regulation of temperature, repeated a number of times, until the product was perfectly colourless, and on solution in water gave no evidence of the presence of impurities, which were searchingly tested for. The reduction of the metal from this purified bromide was accomplished, but with much difficulty and great loss, by heating with pure sodium in a crucible made of, or lined with, a mixture of purified and dry alumina and sodium aluminate. The large globules of aluminum obtained were severally re-fused before the blowpipe on a support of alumina, and were then exposed for a short time to the action of hydrochloric acid on the surface, well washed with water, and dried. On solution of portions of the globules in pure hydrochloric acid, careful testing failed to show the presence of any of the impurities which might have been taken up from the materials and apparatus used. The entire absence of sodium was specially verified.

The colour of this pure aluminum was perceptibly

whiter than that of the commercial metal—on a cut surface very nearly pure tin-white, without bluish tinge, so far as could be judged from the small pieces examined. The lustre, too, was very much that of tin in a fresh, untarnished condition.

The metal was distinctly softer than before purification. Hence its fracture was not easily observed, but seemed to be very fine grained, with some appearance of fibrous silkiness. The malleability was undoubtedly improved, the metal yielding easily to the hammer, and bearing distortion well by flattening in two or three directions without cracking. It seemed to be sensibly less hardened by hammering than the ordinary metal of commerce.

The specific gravity was carefully determined at 4° C., and the mean of three closely concordant experimental results gave the number 2.583 as referred to water at the same temperature.

Hence the "atomic" volume = 10.45, near that of gold (10.19, if the sp. gr. be taken as 19.295, the value found by Roberts for the large trial-plate of fine gold of the English mint), and standing to that of iron nearly as 3:2 (the at. vol. of the latter being 7.11, if the sp. gr. be taken = 7.88, as found by Caron for pure iron fused in the oxy-hydrogen flame).

The specific heat was determined by means of Bunsen's ice calorimeter and found to be = 0.2253 as a mean for the range of temperature 0°—100° C., a number rather higher than those obtained by Regnault and Kopp. This number multiplied by 27.02, the atomic weight found in the experiments for which the metal was prepared, gives the product 6.09 as the atomic heat.

The quantity of pure material at command was not sufficient to allow of any determination of the conductivity, though this would be an interesting point to examine, in view of the high conducting power of the commercial metal, and the probability that the value would be notably raised by the removal of impurities. An imperfect attempt was made to measure the expansion by change of temperature, using for the purpose determinations of specific gravity in water at widely different temperatures, and correcting for expansion of water and glass, but the quantity of material was too small to make the result trustworthy.

It was also attempted to estimate roughly the fusibility, by placing equally heavy beads of the pure and the commercial aluminum in front of a fine blowpipe jet, this jet being fixed in position and fed with air by a steady water blast. From the difference of distance at which the beads could be just fused it seemed probable that the pure metal was a little less fusible than that of commercial character.

Under the same conditions of heating the former seemed to oxidise on the surface with rather more ease than the latter. On the other hand, the pure metal seemed to present perceptibly greater resistance to the prolonged action of solvents—acids and alkalis—than the impure.

University of Virginia,
July 15, 1882.

Indexing Chemical Literature.—The proposition made by Dr. H. Carrington Bolton at the Montreal meeting of the American Association for the Advancement of Science, for organised effort in the preparation of indexes to the elementary substances on a uniform plan,* was favourably received by the members of the Chemical Section. At the meeting held on August 25th, the following Committee was appointed "to devise and inaugurate a plan for the proper indexing of the literature of the chemical elements, said committee to have full power to secure the co-operation of volunteers, and to report at the meeting of the Chemical Section in 1883." Dr. H. C. Bolton, of Hartford, Chairman; Prof. Ira Remsen, of Baltimore; Prof. F. W. Clarke, of Cincinnati; Prof. A. R. Leeds, of Hoboken; Dr. A. A. Julien, of New York.

* *Philosophical Transactions*, Part III., 1880.

* See *CHEMICAL NEWS*, vol. xli., p. 167.

ON THE FIXATION OF
CERTAIN ARTIFICIAL COLOURING MATTERS
BY MEANS OF METALLIC MORDANTS.

By M. HORACE KÆCHLIN.

THE colouring matters which the author has tried are phloxine, ponceau 3R, primrose, magenta, saffraïne, eosine, picric acid, orange No. 2, phosphine, methylene and diphenylamine blues, extract of indigo, orchil, Poirrier's violet, roccelline, binitronaphthol, Bismarck brown, neutral red, induline, and Coupier's grey. The mordants were aluminium, chromium, magnesium, and calcium acetates, singly and mixed.

Phloxine gave a bad result with pure aluminium acetate, a brilliant cherry red with aluminium and magnesium acetates, a bright rose with aluminium and calcium acetates, and an amaranth with chromium and magnesium acetates.

Ponceau 3R gives a bright red with aluminium and magnesium acetates, and a red, imitating madder red, with chromium and magnesium acetates.

Primrose gives with chromium acetate a rather dull red of a violet cast, which bears soaping.

Magenta.—The best result is obtained with chromium acetate, but the colour has little merit.

Saffraïne.—Chromium acetate gives the best colours, but they are of no value.

Eosine gives with chromium acetate a deep red; with aluminium acetate the colour is quite fugitive.

Picric Acid gives with mixed aluminium and magnesium acetates a yellow which does not bear soaping. Nothing with aluminium acetate alone or with chromium acetate.

Orange No. 2 requires a mixture of magnesium and chromium acetates; the latter alone gives a brownish cast, and the former alone is not fast.

Phosphine with aluminium acetate dyes a nankeen yellow which bears boiling soap-lyes.

Blue 5B gives a very deep blue with chromium acetate; with a mixture of magnesium acetate the colour is less intense, but then bears soaping. *Methylene Blue* yields a bad result.

Diphenylamine Blue gives a deep shade with chromium acetate, but does not bear soaping without an admixture of magnesium and aluminium acetates.

Extract of Indigo requires aluminium acetate, but the shade is not fast.

Malachite Green gives the purest shades with a mixture of aluminium and magnesium acetates, but deeper colours are obtained with chromium and magnesium acetates.

Caruline, Poirrier's Violet, and Orchil work best with chromium acetate.

Roccelline gives a brick-red, which does not bear soap with aluminium acetate, or with a mixture of chromium and magnesium acetates.

Binitronaphthol yields no colour.

Bismarck Brown gives a good colour with chromium acetate.

Coupier's Grey requires chromium acetate or a mixture of chromium and magnesium acetates.

Induline dyes under the same conditions as Coupier's Grey.

Many of these colouring matters require the use of double mordants in order to produce the fastest colours. In this respect they agree with the madder dyes, which, however, none of them equal in fastness. The origin of these compound mordants may be traced back to an observation made about the end of the last century by Michael Hausman, who, after having dyed fast madder reds in Normandy could not succeed in producing reds of this quality with the waters of the Vosges, which are free from calcareous matter. Hausman soon remedied this inconvenience by introducing the use of chalk. This addition was the more necessary as he was dyeing with Dutch and Alsatian madders, which are free from lime and very acid. Thus the chalk was at first supposed to

act merely as a neutraliser. Persoz, H. Schlumberger, and D. Kœchlin, brought out the theory of the assimilation of lime to alumina in presence of the colouring principles of madder. These chemists analysed the tissues after every operation of madder-dyeing and proved that the alumina remained in them finally in the state of calcium aluminate, and that the case was similar with iron mordants, and other protoxides, such as those of magnesium, tin, and zinc, &c.

Previous to these researches M. D. Kœchlin called attention to the curious resistance which these compound mordants acquire, and he cited the instance of an aluminous mordant printed upon cloth upon which tin mordants had been previously applied. The cloth, which had been boiled in sours to strip it, took up again the colouring matter, but only where the two mordants were superimposed.

There was then a process known as China Blue, which depended upon these properties. It was indigo blue mixed with chloride of tin. This blue was alternately steeped in lime and copperas; it was slightly soured and preserved its tin. But this base was not sufficient to give a bright weld yellow without a previous passage in alumina. The tin was thus charged with alumina, and could then fix an intense and fast green colour.

To make up calcareous mordants it is necessary to mix a salt of lime with one of alumina and precipitate with sodium carbonate. The mordants of lime and of sesquioxides have not merely more solidity, but the property of giving shades different from those obtained with the sesquioxides alone.

A preparation with stannate is often employed in dyeing as a means of fixing alum or some other sesqui-salt, mordants which in turn may again be charged with protoxides. Tin therefore plays the part of a mordant for alumina in cases which do not require that the mordants should be incapable of being attacked by alkalies.

Compound mordants have a greater resisting power both as regards acids and alkalies, and are therefore suitable for colours which exert one or other of these reactions.—*Monteur Scientifique* (1882, p. 808).

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS, late R.A.

I. INTRODUCTORY, AND ON A NEW BLOWPIPE REAGENT.

THE science to which I have ventured to apply the term "Pyrology," undoubtedly received the chief attention of European chemists and physicists until the time of the great Scheele. The extraordinary efforts and discoveries of that genius, and after him, of Klaproth, brought inorganic chemical analysis by means of water solutions of acids and alkalies into general favour and practice; and the immense and accurate quantitative results obtained by Klaproth (who was evidently, however, educated in the "docimastic" or dry-method school of Pott, of Berlin, for the 50 preliminary pages of his "Analytical Essays" are devoted to the behaviour of "Stones and Earths in the Fire of a Porcelain Furnace") had the final effect of driving dry methods of analysis out of favour, and almost out of sight; in spite of the wonderful discovery of the chemical blowpipe by the Swede, Von Schwabe,* and of its excellent application by Von Engeström, Bergmann, Gahn, Berzelius, Griffin, and Plattner, afterwards, though with defective reagents. Now, no one can for a moment dispute that this succession of chemical events was, in the main, as it ought to have been; and that the wonderful precision, beauty, accuracy, and delicacy of inorganic analysis in the humid way, has only received as it ought

* This word, the ordinary English spelling of which gives it quite a vulgar sound, should be pronounced like the English word *arbour*—*"Shvarbour."*

to have done the chief attention of European chemical philosophers for nearly a hundred years.

But perfection has been apparently attained on this side of analytical chemistry. The genius of Dalton has introduced the subject to mathematics, or mathematics to it; and inorganic chemistry now-a-days is to be considered more as a matter of algebraic rule than of experimental investigation, of abstract orthodoxy than of empiric discovery, of deductive than of inductive consideration.

This being so, if any English, or German, or French, or Russian, or American chemist—if even any ordinary educated individual with so little pretension to chemical knowledge as myself—can *prove* to the satisfaction of European chemical philosophers, that there is another side of inorganic analytical chemistry, almost entirely uninvestigated, which can be applied to and united with spectroscopy and microscopy, until it also can be made to progress speedily towards perfection and mathematical accuracy,—which will not in the least interfere with, but only supplement the perfection attained in established chemical and physical theories,—which can evidently investigate and detect the hiding places of the most minute traces of combined inorganic matter in a new and unexpected manner, impossible to be attained by the use of acids and alkalis except by using large quantities of material,—if, I say, this can be done, and much more, besides the practical utility of analysing complicated minerals and “rocks” in an approximately quantitative manner, on the very spots where they are found, and where it would be impossible to obtain the use of a chemical laboratory,—is it not the duty of our leading chemical and physical philosophers, and, after their *dicta*, of Government itself, to investigate this matter in a proper, thorough, and practical manner, and thus to clear us from the opprobrium which, I fear, we have obtained, in Germany at all events, of “throwing cold water” upon everything new, simply because it is English?

As what I have written on this subject has now been before English chemical readers for many years, in the *Proceedings of the Royal Society*, in your own pages, and those of many of your scientific contemporaries, besides my own books, I will, with your permission, proceed to the description of something which has never been published before—a new blowpipe flux, made by dissolving pure boric acid in a solution of pure phosphoric acid (containing no soda or ammonia) in an evaporating dish on a sand “bath” until crystallisation commences, for, strange as it may seem, crystals are most certainly formed, leaving an intensely acid “mother-liquor,” consisting of phosphoric acid and water.

As I have, however, already perhaps made too large a demand upon your space, I will reserve the description of this new reagent and its apparently important results before the blowpipe, for another article.

INFLUENCE OF PEPTONES AND CERTAIN INORGANIC SALTS ON THE DIASTATIC ACTION OF SALIVA.

By R. H. CHITTENDEN and J. S. ELY.

RECENT experiments* on the diastatic action of saliva under various conditions have revealed the fact that human mixed saliva in the presence of an equal volume of artificial gastric juice containing 0.05 per cent of hydrochloric acid, is capable of forming, from a given quantity of starch, a much larger amount of sugar than the same quantity of saliva alone can do under a like degree of dilution; this being the more remarkable when it is remembered that the same percentage of acid by itself greatly retards the diastatic action. This somewhat

curious fact has led us to study the individual influence of several bodies of physiological importance on salivary fermentation. It is our conviction that many of the digestive processes of the body are more dependent for their fullest action on the stimulating or other influence caused by the mere presence of many of the digestive products than has hitherto been supposed. Experiment, to be sure, has revealed the fact that several of the products of digestion when present in the digestive mixture in excess, notably sugar in the case of salivary digestion and peptones in gastric digestion, retard the digestive process. Under ordinary circumstances, however, all conditions are favourable, in the normal body, for a rapid absorption of the digestive products, and thus any excessive accumulation is prevented. Schmidt-Mülheim* found in his recent study of proteid digestion, that in the case of dogs, the quantity of peptones present in the stomach was practically the same at all times during the digestion; thus 1, 4, and 6 hours after feeding a dog, 61 grms. of albumin, the stomach contained 3.08 grms., 3.31 grms., and 2.91 grms. of peptones respectively, which would seem to indicate that after the formation of a definite quantity of the digestive products the transportation of these bodies keeps pace with the digestion. Again, there are no facts to warrant the belief that the products of one digestive process necessarily hinder the action of some other allied ferment; indeed, it is ordinarily understood that any accumulation of the digestive products simply hinders the action of that particular ferment by clogging the digestive fluid.

There is nothing inconsistent then in the statement that the products of one digestion may act as a stimulant to some other digestive process. The results of the experiments about to be described show plainly that *peptones, a product of gastric digestion, exercise a decided influence on salivary digestion, stimulating the ferment to increased action, particularly in the presence of acid which by itself completely prevents the conversion of starch into sugar.* If now we are led, in virtue of this fact, to infer that there may be a possible continuation of salivary digestion in the stomach, it follows that the ferment must act at the first period of digestion, when the acid fluids are exceedingly weak. The fact that the quantity of peptones present in the stomach at this stage of digestion may be quite small offers no objection whatever to a possible action of the peptones, since the experiments already quoted, and those about to be described, well illustrate how extremely sensitive the saliva is to a change of conditions, however slight; thus even minute quantities of inorganic salts, even to the extent of only 0.015 per cent, exercise a decided influence on ferment action.

We may also reasonably infer that the saliva is, to a certain extent, a type of the other diastatic fluids of the body, and that the ferment itself is doubtless similar in its action to other like ferments, notably the ferment or ferments of the liver, which presumably convert the glycogen of the hepatic cells into sugar. Thus conditions which modify the diastatic action of saliva may not be wholly without similar influence on other like ferments. It has, therefore, seemed to us that the results of our work may have some bearing upon the recently published experiments of Seegen,† of Vienna, who found that when an aqueous solution of peptones was poured over a small piece of fresh liver, the quantity of sugar formed in a specified time was greater than in a piece of the same liver treated in a like manner but without peptones; at the same time, however, the total amount of carbohydrate matter appeared to be increased in the presence of the peptones. Finding that the peptones themselves had no diastatic action on glycogen, Seegen then concluded that the liver possesses the power of transforming peptones into sugar and carbohydrates which are capable of being converted into sugar.

* *Untersuchungen über die Verdaunung der Eiweisskörper*, Dr. Bohts, *Reynolds's Archiv f. Physiologie*, 1879, 39.

† *Die Einwirkung der Leber auf Pepton*, Pflüger's *Archiv*, 25, 165.

* Chittenden and Griswold, *American Chemical Journal*, 3, 305.

While our results may in nowise affect Seegen's conclusions, they certainly suggest the possibility that the increase of sugar noticed in the presence of the peptones may be due, in part at least, to some cause other than that attributed by Seegen.

We have attempted at first in our experiments to ascertain whether by themselves or under such conditions as may presumably exist in the body, peptones have any influence on the conversion of amylaceous matter into sugar by the saliva. The amylaceous material employed was starch and glycogen, while the diastatic agent was human mixed saliva, which was usually collected in quantities of 150—250 c.c. by the chewing of some tasteless substance, then filtered and thoroughly mixed before using. The saliva was ordinarily used an hour or two after collecting, and being as a rule always furnished by the same person, possessed approximately the same strength, although control experiments with starch and saliva alone under a like degree of dilution were made in each case. The method employed consisted in dissolving a weighed amount of starch or glycogen in 25 c.c. of water, then adding 50 c.c. of water or other fluid in which a weighed quantity of peptone or other substance was dissolved, and lastly, 25 c.c. of filtered saliva. The mixture, consisting of 100 c.c. of fluid, was then warmed for a definite time, usually 45 minutes, at 40° C., when further action was prevented by boiling the mixture. The fluid was then diluted with water to 500 c.c., and when thoroughly mixed, 50 c.c., or one-tenth of the filtered fluid, was precipitated by cupro-potassium tartrate, according to the method of Maercker, described in another place.* The copper was weighed as metallic copper, from which the percentage of reducing substance calculated as dextrose was determined by the use of Maercker's tables.

Influence of Peptones in Aqueous Solution.

The peptones employed were prepared especially for the purpose and were made as pure as possible. Three samples were prepared from thoroughly washed blood-fibrin by the action of an active gastric juice made from a glycerine extract of pepsin and 0.2 per cent hydrochloric acid, while the fourth was made from coagulated egg-albumin by the use of a similar gastric juice. All four preparations were the products of an active digestion, and were therefore free from syntonin or other preliminary products. The peptones were purified by repeated precipitation and standing under alcohol and ether, while the fourth was especially purified from soluble salts by dialysis. The following results show plainly the action of the peptones. In each experiment 1 gram. of the dried peptones dissolved in 50 c.c. of water was added to 1 gram. of starch previously boiled with 25 c.c. of water, the 25 c.c. of saliva making a digestive mixture of 100 c.c., in which the peptones were present to the extent of 1 per cent. In the control experiment the mixture was made up to the same volume with water. Different saliva was used in each experiment.

Number of experiment.	Without Peptones.		With Peptones.	
	Wt. Cu in one-tenth.	Total amount of sugar.	Wt. Cu in one-tenth.	Total amount of sugar.
	Grm.	Grm.	Grm.	Grm.
1.	0.0896	0.4557	0.0962	0.4893
2.	0.0911	0.4633	0.0974	0.4954
3.	0.0915	0.4654	0.1045	0.5315
4.	0.0904	0.4598	0.0977	0.4969
5.	0.0856	0.4354	0.0937	0.4766
6.	0.0835	0.4247	0.0949	0.4826

The increased diastatic action of the saliva in the presence of the peptones is made more plainly apparent by the following table, in which are given the percentage amounts of starch converted into sugar; calling the sugar $C_6H_{12}O_6$, and the starch $C_6H_{10}O_5$.

	Without Peptones.	With Peptones.
1.	41.01 per cent.	44.03 per cent.
2.	41.69 "	44.58 "
3.	41.88 "	47.83 "
4.	41.38 "	44.72 "
5.	39.13 "	42.89 "
6.	38.22 "	43.43 "

It is thus seen that the presence of 1 per cent of peptones causes an increased conversion of starch into sugar, amounting on an average to 4 per cent.

Similar experiments made with glycogen yielded like results. 2 grms. of pure, dried glycogen, prepared from *Pecten Irradians** were employed in each experiment, and the digestions continued for 30 minutes. 1 gram. of peptones was used as before.

	Without Peptones.		With Peptones.	
	Wt. Cu in one-tenth.	Total amount of sugar.	Wt. Cu in one-tenth.	Total amount of sugar.
	Grm.	Grm.	Grm.	Grm.
1.	0.1405	0.7297	0.1477	0.7671
2.	0.1286	0.6581	0.1386	0.7144
3.	0.1300	0.6653	0.1328	0.6771
4.	0.1281	0.6556	0.1306	0.6684

A few experiments were then tried, both with glycogen and starch, using 2 grms. of peptones. Following are the results:—

	Without Peptones.		With 1 gram. Peptones.		With 2 grms. Peptones.	
	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.
Starch	0.0835 grm.	0.0949 grm.	0.0960 grm.	0.0960 grm.	0.0960 grm.	0.0960 grm.
Glycogen	0.1405 "	0.1477 "	0.1472 "	0.1472 "	0.1472 "	0.1472 "
"	0.1286 "	0.1386 "	0.1429 "	0.1429 "	0.1429 "	0.1429 "
"	0.1300 "	0.1328 "	0.1362 "	0.1362 "	0.1362 "	0.1362 "

Here it is to be noticed that the presence of 2 per cent of peptones has but little additional influence on the diastatic action. That peptones themselves were entirely free from carbohydrate matter and that the saliva is wholly without action on the peptones was clearly shown by digesting 2 grms. of peptones with 25 c.c. of saliva. This experiment was repeated twice, but in neither case was any reduction obtained on boiling the diluted fluid with Fehling's solution. Again, the possibility suggested itself that the peptones might exercise some influence on the precipitation of the copper, and that the increase of copper obtained when peptones were present was due not to any stimulating action they might exert on the ferment, but to a precipitation or reduction of the copper. In order to settle this point three digestions were made in the usual manner with 2 grms. of glycogen. No. 1 contained, in addition, 2 grms. of peptones. No. 2 had added to it after the destruction of the ferment by boiling, 2 grms. of peptones, while No. 3 served as a control. A determination of the amount of sugar in the aliquoted fluids gave the following results, clearly showing that the mere presence of the peptones has no influence on the precipitation of the copper:—

No. 1.	No. 2.	No. 3.
Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.
0.1472 grm.	0.1403 grm.	0.1405 grm.

There still remained two possible chances of error, viz., the possibility of the peptones containing a trace of a diastatic ferment, or of their possessing a diastatic action, and secondly, that the slightly acid reaction of the peptone solutions might exert some modifying influence. The former supposition was easily disproved by making a digestion of starch and peptones alone. This led, as would naturally be expected, to a negative result; the solution showing no reducing action whatever. An endeavour was then made to obtain the same result in a somewhat different manner: a series of digestions was made, in which one of the peptone solutions was vigorously

* American Chemical Journal, 3, 307.

* Chittenden, Amer. Jour. Science and Arts, 10, 28.

boiled before being added to the starch solution, the digestions then being made in the usual manner.

	Without Peptones.	With 1 grm. Peptones.	Peptone sol. boiled.	Peptone sol. boiled and water replaced.
	Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.
No. 1.	0.0856	0.0937	0.0950	0.0952
No. 2.	0.0904	0.0977	0.1035	—

That the peptones contain no ferment is plainly apparent, but the slight increase of sugar when the peptone solution is boiled is certainly somewhat singular. Three of the peptones employed in these experiments gave, when dissolved in water, very faintly acid solutions. The acidity of 1 grm. of peptones, however, was never sufficient to neutralise the alkali of 25 c.c. of saliva.* The fourth sample, which was purified by dialysis, gave a neutral solution, and this sample did not differ in its action in the least from the other three. An attempt was made, however, to neutralise one of the peptone solutions, previous to the digestion, by the use of an exceedingly dilute alkali. The following results were obtained:—

Without Peptones.	With 1 grm. Peptones.	With 1 grm. neutralised Peptones.
Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.
0.0915 grm.	0.1045 grm.	0.0991 grm.

The slight decrease of copper in the neutralised peptone, as later experiments would seem to indicate, is due probably to the retarding influence of the alkali salt formed by neutralisation, although it seems hardly possible that such a minute trace could exert any influence whatever on the action of the saliva.

O. Nasse† in his work on unformed ferments, found that in 4 per cent. solutions of certain inorganic salts there was an increased ferment action. It therefore seemed desirable to ascertain in the present case whether the inorganic salts contained in the peptones could exert any influence on the salivary ferment. The four samples of peptones contained the following percentages of ash:—

No. 1.	No. 2.	No. 3.	No. 4.
1.71 per cent.	0.89 per cent.	1.25 per cent.	1.58 per cent.

With the exception of No. 4, the ash was composed of sodium chloride, sodium phosphate, and calcium phosphate.

No. 4, which was prepared from coagulated albumin and purified by dialysis, left an ash composed wholly of calcium phosphate. The following results show the individual influence of the three inorganic salts on the diastatic action of saliva when present in the digestive fluid in approximately such percentages as the peptones give when added to the starch and saliva mixture:—

FIRST EXPERIMENT.

			Wt. Cu in one-tenth. Grm.
Saliva and starch alone, ..	..	..	0.0872
" " + 0.012 grm. NaCl = 0.012 per cent.	..	..	0.0862
" " + 0.024 " " = 0.024 " "	..	..	0.0925
" " + 0.012 " Na ₂ HPO ₄ = 0.012 per ct.	..	..	0.0886
" " + 0.024 " " = 0.024 " "	..	..	0.0834

SECOND EXPERIMENT.

			Wt. Cu in one-tenth. Grm.
Saliva and starch alone, ..	..	..	0.0844
" " + 0.015 grm. CaHPO ₄ = 0.015 per ct.	..	..	0.0839
" " + 0.030 " " = 0.030 " "	..	..	0.0870

* Neutral saliva appears to have as great a diastatic action as saliva of normal alkalinity. Thus while a digestion made with freshly collected alkaline saliva gave 0.0905 grm. Cu, a portion of the same saliva neutralised gave 0.0943 grm. Cu under the same conditions.

† Untersuchungen über die ungeformten Fermente, Pfleger's Archiv, 11, 130.

From these results it is apparent that no one of the inorganic salts in the peptones is present in sufficient quantity to have any stimulating action whatever in aqueous solution, for increased diastatic action is noticed only in the presence of 24 milligrams of sodium chloride, an amount much larger than the total ash of 1 grm. of peptones. Again, peptone No. 4, which was freed from all trace of chloride by dialysis, had exactly the same stimulating effect as the other samples.

In order to ascertain exactly what the influence of the mixture of inorganic salts, as present in the peptones, would be, a series of digestions was made, in two of which the ash of 1 grm. and of 2 grms. of peptones respectively were employed; the ash, as in the experiments with the peptones themselves, being dissolved in 50 c.c. of water, and in this manner added to the starch solution previous to the addition of the 25 c.c. of saliva. The peptones employed were the ones which contained 1.71 per cent of ash; thus the digestive mixtures contained respectively 0.017 and 0.034 per cent of inorganic matter. The following results were obtained:—

Saliva and Starch alone.	With Ash from 1 grm. Peptones.	With Ash from 2 grms. Peptones.
Wt. Cu in one-tenth.	Wt. Cu in one-tenth.	Wt. Cu in one-tenth.
0.0862 grm.	0.0851 grm.	0.0715 grm.

It is thus very apparent that the stimulating action of the peptones is not due to the inorganic salts contained in them, for these latter, as the foregoing experiment shows, have, by themselves, in aqueous solution, a retarding influence. We therefore deem it proven that peptones under such conditions as have already been described, have in aqueous solution a stimulating influence on salivary digestion. In other words, peptones when present to the extent of 1-2 per cent cause, under the same conditions as saliva alone, an increased conversion of starch into sugar, amounting on an average to 4 per cent.

(To be continued.)

NOTICES OF BOOKS.

Journal and Proceedings of the Royal Society of New South Wales, 1881. Vol. XV. Edited by A. LIVERIDGE, Professor of Chemistry and Mineralogy in the University of Sydney. Sydney: Richards. London: Trübner and Co.

This volume does not contain many papers specially interesting to the chemist. There is a memoir by W. A. Dixon, F.C.S., on the "Inorganic Constituents of some Epiphytic Ferns," of some importance as proving that the amount of ash in the growing fronds is quite as high as in the leaves of plants which obtain their nourishment directly from the soil. The inorganic principles most abundant in ordinary vegetation play here likewise the leading part. Thus in the ash of *Platyserium grande* potash, lime, and phosphoric acid are respectively present to the extent of, in round numbers, 33, 21, and 9 per cent. A remarkable phenomenon is the presence of 11 per cent soda (exclusive of sodium chloride) and of 8 per cent of alumina. On turning to the analysis of the wood and bark of the tree upon which this fern was a parasite, we find no alumina and no soda except traces of sodium chloride. It appears, therefore, that the *Platyserium* must obtain these constituents from the dust which collects behind the crown of the plant. It may be mentioned that Mr. Dixon took the precaution of obtaining his specimens from localities far from towns and cultivated grounds. The ash of *P. Alcorni* taken from different localities showed considerable variation, though alumina was always largely present. Here lime and magnesia seem capable of to some extent replacing each other. Thus in one specimen were found potash 20, soda 17, sodium chloride 12, lime 13, and magnesia 14 per cent.

In another the potash is 40 and soda 21, whilst the lime is only 5 and the magnesia 4 per cent. *Asplenium nidus* is free from alumina, and contains no soda except in the form of sodium chloride.

Investigations of this kind are exceedingly valuable, and should be extended.

OBITUARY.

THE LATE PROFESSOR WÖHLER.

ONE of the links between the chemistry of the present day and that of the earlier part of the century has just been severed. Friedrich Wöhler, for many years Professor of chemistry at the University of Göttingen has finished his long and honourable career. He was born in the year 1800, being the junior of Prof. Dumas by a few days only. He was the favourite pupil of the great Berzelius, and displayed in an eminent degree the patience, the exactitude, and the sobriety of judgment which characterised his illustrious master. From about 1821 to within the last few years he produced what may be called a stream of valuable researches, which are embodied in no fewer than 225 memoirs presented to learned societies or published in the scientific journals.

Amongst his labours, judging from a purely scientific point of view, the foremost place belongs to the "epoch-making" discovery of the synthesis of urea. This was the first instance of an organic compound being produced artificially without the intervention of life. The discovery produced a great sensation, as breaking down the supposed absolute distinction between the organic and the inorganic worlds.

More recently he distinguished himself by the isolation of metallic aluminium, and by his labours on the platinum metals and on their practical metallurgy. In these researches he was associated with his friend the late H. Sainte-Claire Deville.

In conjunction with another of his friends, Justus Liebig, he produced also certain important researches in organic chemistry. Their joint investigation on the derivatives of uric acid has proved, in the hands of their successors, a perfect mine of interesting novelties, and their memoir on the nature of the benzoic compounds brought into harmonious connection a hitherto desultory mob of phenomena.

Since the death of Liebig, Wöhler has been the first editor of that universally esteemed journal *Liebig's Annalen*, though of late years the principal part of the editorial duties have devolved upon his colleagues, Professors Kopp, Hofmann, Kekulé, Erlenmeyer, and Volhard.

As a colleague, a teacher, and in every relation of private life, Wöhler was esteemed and beloved for the kindness and geniality of his disposition, his modesty, and uprightness. Many successive generations of students, now dispersed over the world, can bear witness to his readiness to perceive and aid merit. He gave his pupils his own ideas, aided them in carrying out the needful investigations, and kept his share in the work a secret. Those who maintain that a life devoted to science renders a man harsh, proud, and selfish, will find in the person of Friedrich Wöhler a brilliant refutation of their doctrine.

Cause of Acid Reaction in Certain Kinds of Paper.—Prof. Feichtinger.—Papers sized with rosin-size were found to have a more or less acid reaction due to free sulphuric acid, which has never been observed in samples sized with animal glue. The acid is probably derived from the alum or aluminium sulphate used in sizing, which is decomposed by contact with the vegetable fibre, as takes place in dyeing, a basic salt being deposited upon the fibre, and a portion of acid liberated.—*Chemiker Zeitung*.

CORRESPONDENCE.

SECONDARY BATTERY.

To the Editor of the Chemical News.

SIR,—As the question of secondary batteries is at present engaging the attention of electricians and chemists, I would like to bring before your readers a form which I have tried a few experiments with, and which seems very promising. It occurred to me some time ago that Bennett's* cell might be improved if there were oxide of iron present to be reduced by the hydrogen evolved, and upon trial I found that a plate of zinc and a plate of rusty iron, immersed in caustic soda solution, gave a very constant current for some time. Now, suppose such a battery used for a considerable time: the zinc would become coated with zinc oxide, and the iron oxide reduced to spongy iron. Suppose that now a current is sent into the cell in a direction opposite to that of its own current, the ZnO will be reduced to metal, and the iron oxidised; consequently the cell will be refreshed, and able to give out a strong current again until all the iron oxide is reduced.

As caustic soda would not keep very long without becoming carbonate, I tried sodium carbonate in the cell with which I experimented, and which consists of a rusty iron cylinder containing the solution, and a cylinder of zinc which had been superficially oxidised by long exposure to the air. This combination only gives a trace of current of itself, but when charged with at least three Daniell cells is capable of giving out a very considerable secondary current. I have no doubt that other neutral salts, of better conducting power, would be more suitable than sodium carbonate, and I intend to continue my experiments in that direction, but in the meantime would be glad of information as to whether such a combination has been suggested before as a secondary battery, for, if so, I am ignorant of it.—I am, &c.,

THOMAS FARRINGTON.

4, Waterloo Place, Cork, October 10, 1882.

A WARNING.

To the Editor of the Chemical News.

SIR,—Would you kindly permit me, through the medium of the *CHEMICAL NEWS*, to forewarn chemists against a foreigner (Swiss, I believe) giving the name of Schmidt, Ph.D., who represents himself as an analyst in search of employment. He represented to me that he was engaged at a neighbouring chemical works, to commence duties the following Monday, and being in need of ready cash I advanced him £1. On his never turning up, as arranged, to refund me, I made enquiries, and find that his stories are entirely false, and he, of course, "non est," and doubtless on his rounds trying to impose on someone else.—I am, &c.,

ALEXANDER PROUDLOCK.

Chemical Laboratory, Airedale Iron Works,
Leeds, October 11, 1882.

FORMATION OF OZONE.

To the Editor of the Chemical News.

SIR,—If Mr. R. Lamont will consult my paper "On the Atmospheric Oxidation of Phosphorus" (*Journ. Chem. Soc. Trans.*, 1880, p. 797), he will find that oxygenated water is not materially, if at all, decomposed by dilute ozone, and also that oxygenated water is one of the principal products of the oxidation of phosphorus in the presence of water. It is necessary, therefore, and for the other reasons given in my recent article (*CHEMICAL NEWS*

* Zinc and iron in caustic soda solution.

vol. xlv., p. 141), that if Mr. Lamont would correctly represent by equations the chemical changes that occur during the process to which I have made reference, he must introduce water.—I am, &c.,

C. T. KINGZETT.

Chemical Laboratory, 17, Lansdowne Road,
Tottenham, N., October 16, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Notes.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 13, September 25, 1882.

Analysis of the Milk of the Galibis Women at the Jardin d'Acclimation.—Mme. Madeleine Brès.—These milks are rich in lactose and butter, whilst the proportion of caseine is exceedingly small.

No. 14, October 2, 1882.

The Coercitive Force of Steel rendered Permanent by Compression.—L. Clémandot.—Steel tempered by compression, that is, cooled under pressure, retains its coercive power in spite of re-heating, forging, &c.

Nature of the Vibratory Movements which accompany the Propagation of Flame in Combustible Gaseous Mixtures.—MM. Mallard and Le Chatelier.—When a combustible gaseous mixture included in a tube closed at one end and open at the other, is kindled at the free extremity, the flame is propagated at first slowly, very regularly, and without producing any sound; then it begins to oscillate, its speed is accelerated, and at last there is heard a sound more or less intense. The authors have measured the duration of the vibratory movements, their amplitudes, their influence on the lustre of the flame, and their mean speed of propagation.

Action of Anhydrous Aluminium Chloride upon Acetone.—E. Louise.—Acetone, mixed with anhydrous aluminium chloride, enters into ebullition, and on applying a gentle heat and keeping up the reaction by successive additions of aluminium chloride, the mixture of the two substances is transformed into a blackish solid mass, over which is a stratum of a black liquid. If the crude product is distilled in a current of steam, there passes over a yellow liquid, insoluble in water. The most volatile portion of the purified mixture is chiefly composed of mesityl oxide, $C_6H_{10}O$. The less volatile portion consists of crystalline phorone and of higher products of condensation which do not crystallise.

Chemiker Zeitung.
Vol. vi., No. 48.

Chemical Laboratory of the Royal Mining Academy of Clausthal.—Prof. W. Hampe.—A lengthy paper with several illustrations.

No. 49, 1882.

Preparation of Pure Hydrochloric Acid.—Dr. Giudice.—The author adds to the sulphuric acid employed a small quantity of an oxidising agent, such as potassium bichromate or permanganate, and causes the gas, before it is conducted into water, to pass over mercury in a Liebig's bulb-tube. The oxidising body prevents the formation of sulphurous anhydride in presence of organic matter, and liberates bromine and iodine if present. Arsenic-chloride is decomposed in contact with the mercury and free chlorine, bromine, and iodine, are absorbed.

Detection of Arsenic Microscopically.—Dr. H. Hager.—The process depends on the reducing-action of

oxalic acid or ammonium oxalate upon arsenic and arsenious acids in heat. If the liquid to be tested contains no fixed heavy metals, which when partially or entirely reduced present dark masses, the detection can be effected microscopically. In concentrated sulphuric acid it is sufficient to heat 2 or 3 c.c. of the colourless sample with some colourless crystals of oxalic acid in a test-tube. If the acid contains more than a trace of arsenic, it is coloured brown, but it remains colourless if pure. If other liquids are to be examined, e.g., phosphoric or acetic acids, 1.5 c.c. of the acid is taken mixed with 3 drops of glycerin, 0.25 gm. oxalic acid, and a few drops of ammonia. The mixture is heated, and a drop is placed on a glass slip. The finely-divided arsenic can be seen with the microscope as a dark grey or a black mass.

Detection of Lead in Presence of Ammonium Citrate.—S. Rovera.—Whilst examining quinine citrate for an admixture of quinine sulphate, the author observed that lead in presence of ammonium citrate is not precipitated from an alkaline solution by sulphuric acid or an alkaline sulphate. It is, however, completely precipitated by potassium or sodium carbonate.

Cosmos Les Mondes.

Nos. 1 and 2, September 2 and 9, 1882.

These numbers contain no chemical matter.

Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 7.

The Daily Course of Rainfall.—F. Augustin.—The author, from twenty years' observation of the hourly rainfall made at Prague and compared with pluviometric determinations at Modena, Bern, Vienna, and Zechen, concludes that both in the quantity of downfall and in the frequency of rainfall there are three daily maxima and three minima. The first minimum is as regards frequency from midnight to 1 a.m., but as regards quantity from 2 to 3 a.m. This in all the stations except Bern is the most decided minimum, both for quantity and frequency. The first maximum coincides with or follows shortly after the minimum daily temperature. As regards frequency, it occurs from 6 to 7 a.m., but as regards quantity, from 7 to 8. The second minimum, both in quantity and frequency, is about noon. The second maximum is a short time after the maximum daily temperature, from about 4 to 5 p.m. The third minimum is about 7 p.m., and the third maximum is, in frequency, from 8 to 9, and in quantity from 9 to 10 p.m.

Influence of Artificial Manures upon the Physical Conditions of the Soil.—Prof. E. Wollny.—The author remarks that a fruitful arable soil has its smallest particles not densely aggregated, but in a crumbly, fragmentary state, so that air and water can circulate between them. Copious manuring with substances rich in chlorides, nitrates, and sulphates, and saline irrigations, have an injurious effect upon the texture of clay soils. Quicklime has the most favourable action.

Changes in the Properties of the Nitre Ferment by Cultivation.—R. Warington.—From the "Report of the British Association for 1881."

Experiments on a Four Years' Rotation.—Dr. A. Voelcker.—From the *Journal of the Agricultural Society*.

Experiments on the Uninterrupted Cultivation of Wheat and Barley at Woburn.—Dr. A. Voelcker.—From the *Journal of the Agricultural Society*.

Cultural Experiments on the Field at Grignon in 1881.—Prof. P. P. Dehérain.—The manures applied to the different plots seem to have been altered irregularly, so that it is difficult to find comparable conditions, or to know to what influence any given result is to be ascribed.

Manuring with Phosphoric Acid in the Department Nord (France).—M. Ladureau.—Already noticed.

Agricultural Value of so-called dissolved Wool.—Prof. A. Petermann.—Wool dissolved by means of sulphuric acid, or of high-pressure steam, and containing its nitrogen to a large extent in the form of tyrosine and leucine, has, at least in the sandy loam experimented on, a very favourable effect.

Action of Dissolved and of Finely-ground Phosphates in the Cultivation of Swedes.—Dr. A. Voelcker.—From the *Journ. Agricul. Soc.*

Agricultural Value of the Different Combinations of Phosphoric Acid.—Dr. E. Wildt.—The experiments show no marked difference between the action of reverted and precipitated calcium phosphate, whilst phosphoric acid soluble in water produced in almost all cases a more considerable increase of the yield than that soluble in citric acid, the reverted, and the precipitated forms.

Composition of Various Materials Suitable for Composts.—Prof. Petermann.—Tables showing the nitrogen, phosphoric acid, potash, and lime present in various kinds of industrial refuse and in pond-muds.

Researches on the Digestibility and the Quantitative Determination of the Albumenoids.—Dr. A. Stutzer.—The determination of the proteine nitrogen and the separation of the proteine compounds from other nitrogenous bodies can be easily and accurately effected. The so-called proteine matters of cattle foods consist of two physiologically and chemically distinct classes, which may be known as albumenoids and as nucleine. The albumenoids are converted into soluble compounds, both by the acid gastric juice and by the alkaline pancreatic secretion. Not so nucleine,—a fact which must be considered in determining the value of articles of food. The digestibility of the proteine substance depends in the first place on their chemical composition, i.e., on their proportion of digestible albumen. The albumenoid nitrogen can be best determined and separated from nucleine nitrogen by means of artificial digestion.

Effects of External Influences on the Formal Development of the Wheat Plant.—Dr. H. v. Breislach. This paper is more of a botanical than of a chemical character.

Examination of a Mixture of the Seeds of Weeds used in Cattle Food.—Prof. F. Nobbe.—The author considers this mixture not injurious, but low in nutritive value.

Experiments on the Growth of Various Plants.—Dr. Kraus, Prof. Leydhecker, and J. Tudor.—Not adapted for abstraction.

Influence of Lopping the Crown and the Roots of Fruit Trees on Transplantation.—Prof. Magerstein and F. Bilek.—This paper does not fall within the scope of the CHEMICAL NEWS.

Experiments on Vegetation in Atmospheres Rich in Carbonic Acid.—P. Dehérain and L. Maquenne.—Plants which have an excess of carbonic acid at command are found to derive a decided advantage.

Communication on Sorghum tartaricum.—Dr. de Leeuw.—The seed of this plant, known in commerce as dari, contains 66.6 per cent of starch, and is used in Belgian distilleries.

Products of the Distillation of Beet-dregs.—Ch. Lauth.—The concentrated liquid when submitted to dry distillation yields ammonia, methylic alcohol, acetic acid, small quantities of the higher fatty acids, nitriles of these acids, methylamine, and tar.

Influence of Different Steeping Waters.—Karl Michel.—Experiments on the action of distilled water and spring water in steeping barley.

Detection of Myronic Acid in Oil-cake (a preliminary communication).—V. Dirks.—The oil-cake is

mixed with water, allowed to stand, and the oil of mustard is distilled into an alkaline solution of permanganate.

Justus Liebig's Annalen der Chemie,
Band 214, Hefte 1 and 2.

Hydro-cinchonidine.—O. Heise.—Hydro-cinchonidine melts at 229° to 230°. It crystallises from hot dilute alcohol in splendid hexagonal leaflets, but from strong alcohol in short prisms. In alcohol it dissolves less readily than cinchonidine and homo-cinchonidine. In chloroform, even boiling, in ether, and water, it is very sparingly soluble. It dissolves readily and without colouration in strong sulphuric and nitric acids. Its acid solutions, even when much diluted, do not display the slightest blue fluorescence. With chlorine and excess of ammonia it gives no colouration. In caustic alkaline solutions and in lime and baryta water it is insoluble. In an acid solution it is only very slowly attacked by potassium permanganate. Its composition is $C_{19}H_{24}N_4O$.

Urea and Thio-urea Derivatives of Phthalic Acid.—Dr. A. Piutti.—The author has obtained and described phthaluric acid and its salts; phthalureide, thio-phthaluric acid, and certain of its salts.

Communications from the Chemical Laboratory of the Royal School of Forestry at Aschaffenburg.—These consist of the following syntheses by means of malonic ester: Methenyl-tricarboxylic ester and acetmalonic ester, by M. Conrad and M. Guthzeit; ethenyl-tricarboxylic ester, by C. A. Bischoff; mono-chlor-ethenyl-tricarboxylic ester, by C. A. Bischoff; propenyl-tricarboxylic ester, by C. A. Bischoff; propyl- and isopropyl-ethenyl-tricarboxylic ester, by G. Waltz; isallylen-tetra-carboxylic ester, by C. A. Bischoff; acetylen-tetra-carboxylic tetraethyl-ester, by M. Conrad and C. A. Bischoff; acetylen-tetra-carboxylic diethyl-ester, by M. Guthzeit; dicarboxy-tetra-carboxylic ester, by M. Conrad and M. Guthzeit.

Action of Phosphorus Penta-chloride upon Acid Amides (Second Memoir).—O. Wallach.—Not adapted for useful abstraction.

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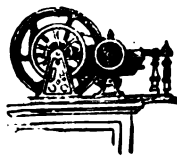
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THE CHEMICAL NEWS

Vol. XLVI. No. 1192 28 OCT 82

ANALYSES OF INDIAN

By W. R. CRIPER, F.R.C., &c.

THE trees chiefly used for fuel in the North West Provinces of India are Mango (*Mangifera Indica*), Sakhu or Sál (*Shorea robusta*), and Dhák or Dháka (*Butea frondosa*). Samples for analysis were taken in the month of June from a stock ready for use, which had been lying exposed to the atmosphere during the preceding hot season, and was consequently dry, i.e., containing about 10 per cent of moisture only. The samples included the bark.

	Mango.	Sál.	Dháka.
Carbon	42.72	43.58	40.61
Hydrogen	5.70	5.45	5.11
Oxygen and nitrogen	36.23	38.09	35.36
Ash	2.88	1.24	6.25
Sand	2.97	0.44	1.00
Water.. ..	9.50	11.20	11.67
	100.00	100.00	100.00
Heat units, calculated from an analysis, not including sand ..	3634	3458	3259

During the rainy season about 20 per cent of water is the usual amount contained in the wood, for which percentage the heat units given by Sakhu or Sál would be 3054, which may be considered the average.

In a series of 31 samples of coal from the Ranigunge district, Bengal, analysed by the Indian Geological Survey (vide *Records of the Geological Survey of India*, vol. x., p. 155), the heating effect of the best sample is given as 7040 heat units.

The ratio of coal to wood in India may therefore be considered as 2.32 to 1, i.e., for equal weights the coal has 2.32 times the heating power of ordinary wood, theoretically.

LABORATORY NOTES.

By R. ROMANIS.

Government Laboratory, British Burmah.

THE town of Rangcon is supplied with water from the Royal Lake, a reservoir made by some of the former kings of Pegu, near the Great Pagoda. It is filled during the rains which last from June to October. During the hot weather it slowly shrinks, while a mass of vegetation is developed in the water. Samples of the water have been regularly examined by the ammonia process, once a month since May, 1881. The results are appended. The effect of the rains in diluting the organic matter is apparent in July, and is at its maximum in August, the wettest month of the year. A curious evolution of free ammonia is shown in March, possibly connected with some stage in the development of the organisms in the water. Although the water contains so much organic ammonia as would probably ensure its being condemned at home, yet it has made a great improvement in the health of the quarter of the town to which it was first laid on about five years ago—a marshy district near the river where fever greatly prevailed, possibly because the wells formerly in use were so bad that any change was for the better.

Free Ammonia. Alb. Ammonia.

1881—May	0.00	0.60
June	0.02	0.68
July	0.00	0.36
August	0.02	0.24
September ..	0.05	0.26
October 10 ..	0.00	0.30
October 20 ..	0.00	0.32
November ..	0.04	0.36
December ..	0.00	0.36
1882—January ..	0.00	0.38
February ..	0.00	0.68
March 11 ..	0.16	0.42
March 15 ..	0.16	0.44
April	0.00	0.64
May	0.03	0.64
June	0.03	0.72
July	0.01	0.82
August	0.00	0.32
September ..	0.06	0.26

JAPANESE SOILS—A NATURAL CEMENT.*

By Dr. O. KORSCHULT.

THE author of this paper, the chemist to the Geological Survey Department of the Japanese Government, was led to look for a natural cement. Such cements are formed by mixing burnt lime with substances of volcanic origin, generally tufas. Since a preliminary burning is not necessary, neither in many cases any grinding, the cement can be formed on the spot where it is required for building without the intervention of any special factory, such as is required for Portland or Roman cement. Materials for the manufacture of such cements have been found in a few places in Europe; in Italy between Rome and Viterbo, and near Naples at Pozzuoli (whence *Pozzuolana*); in Germany, at Brohlthal and Nettethal near the Laacher See, near Andernach and Neuwied on the Rhine, and in the Riesgau, also in the north of Ireland and in Auvergne. Those from Germany and the last-named places are known, when in the powdered condition, as *trass*: they all contain constituents which are soluble in hydrochloric acid to the extent of about one-half their weight. Besides these, the island of Santorin, and one or two other Grecian islands, furnish a siliceous earth, used for the same purpose, which is insoluble in hydrochloric acid, but contains much silica soluble in potash solution.

Dr. Korschelt first experimented with the tufa rocks of Japan, which differ from those used in Europe for making cements in being chiefly augite-andesite and trachyte, whilst the European rocks are, for the most part, leucite-bearing tufas: experiments with these rocks were unsuccessful. It was noticed, however, that some of the soils of Japan yielded a large amount of matter to cold concentrated hydrochloric acid, and contained large quantities of hydrated oxides of iron and aluminium. Layers of soil, 25 centimetres in thickness, to a depth of 1.5 metres, taken from the city of Tokio (Yedo) were analysed. The dry soil from one of the low lands gave up from 75 to 80 per cent to hot hydrochloric acid; of this about 30 per cent was silica and 30 per cent alumina and ferric oxide. From 1.5 to 3 per cent of potash soluble in hydrochloric acid was found in the lower layers of this soil, but this is an unusual amount. These soils are generally called loams, but chemically they can scarcely come into that class, as they contain little or no quartz sand, and only about 10 per cent of mineral sand, but 50 to 60 per cent of easily decomposable silicates of the nature of zeolites, and about 30 per cent of aluminium and iron hydrates. The insoluble mineral sand consists principally of sanidine

* Abstract of Paper in *Mittheilungen der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens*, 1881.

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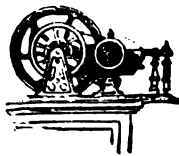
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ANALYSES OF INDIAN

By W. R. CRIPER, F.R.C., &c.

THE trees chiefly used for fuel in the North West Provinces of India are Mango (*Mangifera Indica*), Sakhu or Sál (*Shorea robusta*), and Dhák or Dháka (*Butea frondosa*). Samples for analysis were taken in the month of June from a stock ready for use, which had been lying exposed to the atmosphere during the preceding hot season, and was consequently dry, i.e., containing about 10 per cent of moisture only. The samples included the bark.

	Mango.	Sál.	Dhák.
Carbon	42.72	43.58	40.61
Hydrogen	5.70	5.45	5.11
Oxygen and nitrogen	36.23	38.09	35.36
Ash	2.88	1.24	6.25
Sand	2.97	0.44	1.00
Water	9.50	11.20	11.67
	100.00	100.00	100.00
Heat units, calculated from an analysis, not including sand ..	3634	3458	3259

During the rainy season about 20 per cent of water is the usual amount contained in the wood, for which percentage the heat units given by Sakhu or Sál would be 3054, which may be considered the average.

In a series of 31 samples of coal from the Ranigunge district, Bengal, analysed by the Indian Geological Survey (vide *Records of the Geological Survey of India*, vol. x., p. 155), the heating effect of the best sample is given as 7040 heat units.

The ratio of coal to wood in India may therefore be considered as 2.32 to 1, i.e., for equal weights the coal has 2.32 times the heating power of ordinary wood, theoretically.

LABORATORY NOTES.

By R. ROMANIS.

Government Laboratory, British Burmah.

THE town of Rangcon is supplied with water from the Royal Lake, a reservoir made by some of the former kings of Pegu, near the Great Pagoda. It is filled during the rains which last from June to October. During the hot weather it slowly shrinks, while a mass of vegetation is developed in the water. Samples of the water have been regularly examined by the ammonia process, once a month since May, 1881. The results are appended. The effect of the rains in diluting the organic matter is apparent in July, and is at its maximum in August, the wettest month of the year. A curious evolution of free ammonia is shown in March, possibly connected with some stage in the development of the organisms in the water. Although the water contains so much organic ammonia as would probably ensure its being condemned at home, yet it has made a great improvement in the health of the quarter of the town to which it was first laid on about five years ago—a marshy district near the river where fever greatly prevailed, possibly because the wells formerly in use were so bad that any change was for the better.

Free Ammonia. Alb. Ammonia.

1881—May	0.00	0.60
June	0.02	0.68
July	0.00	0.36
August	0.02	0.24
September	0.05	0.26
October 10	0.00	0.30
October 20	0.00	0.32
November	0.04	0.36
December	0.00	0.36
1882—January	0.00	0.38
February	0.00	0.68
March 11	0.16	0.42
March 15	0.16	0.44
April	0.00	0.64
May	0.03	0.64
June	0.03	0.72
July	0.01	0.82
August	0.00	0.32
September	0.06	0.26

JAPANESE SOILS—A NATURAL CEMENT.*

By Dr. O. KORSCHULT.

THE author of this paper, the chemist to the Geological Survey Department of the Japanese Government, was led to look for a natural cement. Such cements are formed by mixing burnt lime with substances of volcanic origin, generally tufas. Since a preliminary burning is not necessary, neither in many cases any grinding, the cement can be formed on the spot where it is required for building without the intervention of any special factory, such as is required for Portland or Roman cement. Materials for the manufacture of such cements have been found in a few places in Europe; in Italy between Rome and Viterbo, and near Naples at Pozzuoli (whence *Pozzuolana*); in Germany, at Brohlthal and Nettethal near the Laacher See, near Andernach and Neuwied on the Rhine, and in the Riesgau, also in the north of Ireland and in Auvergne. Those from Germany and the last-named places are known, when in the powdered condition, as *trass*: they all contain constituents which are soluble in hydrochloric acid to the extent of about one-half their weight. Besides these, the island of Santorin, and one or two other Grecian islands, furnish a siliceous earth, used for the same purpose, which is insoluble in hydrochloric acid, but contains much silica soluble in potash solution.

Dr. Korschelt first experimented with the tufa rocks of Japan, which differ from those used in Europe for making cements in being chiefly augit-andesite and trachyte, whilst the European rocks are, for the most part, leucite-bearing tufas: experiments with these rocks were unsuccessful. It was noticed, however, that some of the soils of Japan yielded a large amount of matter to cold concentrated hydrochloric acid, and contained large quantities of hydrated oxides of iron and aluminium. Layers of soil, 25 centimetres in thickness, to a depth of 1.5 metres, taken from the city of Tokio (Yedo) were analysed. The dry soil from one of the low lands gave up from 75 to 80 per cent to hot hydrochloric acid; of this about 30 per cent was silica and 30 per cent alumina and ferric oxide. From 1.5 to 3 per cent of potash soluble in hydrochloric acid was found in the lower layers of this soil, but this is an unusual amount. These soils are generally called loams, but chemically they can scarcely come into that class, as they contain little or no quartz sand, and only about 10 per cent of mineral sand, but 50 to 60 per cent of easily decomposable silicates of the nature of zeolites, and about 30 per cent of aluminium and iron hydrates. The insoluble mineral sand consists principally of sanidine

* Abstract of Paper in *Mittheilungen der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens*, 1881.

and plagioclasic felspar with a little augite, the tufa from which it is formed being trachytic or augite-andesite.

These tufa soils have a very low specific gravity, less than that of all other soils, excepting only peaty soils. In fifteen samples the specific gravity varied from 2.097 to 2.291, the mean being 2.156, whilst the *apparent* specific weight, obtained by dividing the absolute weight of a given volume of the soil in its natural condition by the weight of an equal volume of water, was between 1.038 and 1.270, the mean being 1.135.

Mechanical analyses were made of twenty-two samples by means of Schöne's and Ort's apparatus. Only about 3 per cent of the soil particles had a greater diameter than 0.5 millimetres, and about 70 per cent were less than 0.09 millimetre in diameter. It was also found that the physical composition of the soils varied comparatively slightly either with varying depth or from different localities. The chemical composition of these tufa soils also varies but little: we give the analyses of one series from a village in Saitama Ken as an example:—

	Depth of Soil in centimetres.				
	0-25.	25-37.	37-50.	50-75.	75-100.
Hygroscopic water..	12.49	13.01	14.90	18.34	19.10
Loss on ignition ..	29.99	32.66	30.68	32.28	33.10
Alumina	8.30	9.81	11.07	11.33	11.40
Ferric oxide	5.95	6.20	6.79	9.24	8.66
Lime.. .. .	0.69	0.60	0.32	0.21	0.15
Magnesia.. .. .	0.34	0.34	0.44	0.32	0.37
Potash	0.05	0.07	0.06	0.05	0.06
Sulphur trioxide ..	0.07	0.09	0.07	0.07	0.12
Phosphorus pentoxide	0.07	0.07	0.05	0.07	0.07
Carbon dioxide ..	0.08	0.07	—	—	—
Carbon	7.22	6.30	2.86	1.56	1.63
Nitrogen	0.39	0.35	0.18	0.12	0.12

Some of these tufa soils, which were of a whitish colour, refused to form a satisfactory cement when mixed with lime, but those of a reddish yellow or reddish brown colour, when mixed with lime paste, quickly set and hardened, forming a highly satisfactory cement. The chemical action taking place at the time of mixing was indicated by a rise in temperature of 7° C. Suitable soils were found on nearly all the high parts of Tokio, and to a depth of about 20 feet. Complete analyses of some typical specimens are given, and the composition of a suitable tufa earth is stated to be as follows:—Organic matter, 1 per cent; zeolites and hydrates of sesquioxides, 85; clay, 1.5; quartz sand, 1.5; and mineral sand, 11 per cent. The most suitable mixture was found to be 1 volume of burnt lime, made to a stiff paste, mixed with 6 volumes of earth. The hardness of the cement was found to be sufficient for most purposes, and also its resistance to crushing, although this latter could not be determined with exactness owing to the want of a testing apparatus; however, it always resisted a pressure of over 12 kilogrms. per square centimetre on a thickness of 3 centimetres. It is also impermeable to water. Experiments were also made by mixing the earth with sand before adding the lime; this increased the density and value of the cement, but is not to be generally recommended owing to the difficulty of obtaining sand sufficiently sharp for the purpose; in many places, however, a pumice-tufa is met with which answers admirably for mixing with the earth.

The tufa earth is met with over a large part of Japan, and in many different districts. Its value for the building of dwelling-houses can scarcely be overrated. From its abundance houses can be constructed of it as cheaply as, if not more cheaply than, of wood, and by its means the fearfully destructive fires, which are estimated to burn down the whole of any large town within ten years, would be to a large extent prevented.* The habits of the people would not allow of brick or cement houses being generally adopted at once, but there could be no objection to the two side-walls of the house being of this cement.

* In the winter of 1880-81, in the city of Tokio alone, considerably more than 20,000 houses were destroyed by fire.

In a postscript the author states that he finds that a decomposed granite grit found in parts of Japan where the tufa is absent forms an excellent cement material, and is indeed a most acceptable supplement to the tufa earths.

Dr. Korschelt makes some suggestions as to a new system of soil nomenclature by which the confusion now arising from using certain terms, such as sand and clay, sometimes in a chemical sense and sometimes in a physical sense, would be avoided. The six chemical constituents, clay, sand (quartz), mineral grains (other than quartz), zeolites, including hydrates of sesquioxides, carbonate of lime, and humus, are taken as the basis of chemical distinctions; and the fine earth is divided according to the diameter of the particles, ascertained by the mechanical analysis, into four principal divisions; by making compound words, often of some length, denoting the chemical and physical constituents, the constitution of any soil can be expressed with accuracy.

The results of previous investigations of Japanese soils, and remarks on their agricultural value are given. E. Kinch (*Transactions of the Asiatic Society of Japan*, 1880) analysed several soils: among these were four tufa soils differing but little in composition from those examined by the author. These soils all contained magnetic oxide of iron, as indeed do the great majority of Japanese soils, and in the surface-soil the amount is much larger than in the subsoil, indicating a considerable denudation, whereby the heavy magnetic oxide was left and accumulated in the top soil. The views of D. Brauns on the geology of the neighbourhood of Tokio (*Memoirs of the University of Tokio*, No. 4) are criticised and dissented from.

In considering the agricultural attributes of these tufa soils, the author endorses the view expressed by Kinch (*loc. cit.*), that these soils are admirably adapted from their physical properties to the system of agriculture pursued by the Japanese farmer, but that viewed as a storehouse of plant-food they are usually poor. They contain a very large amount of the finest particles, but are quickly and easily cultivated and sufficiently adherent. They possess great absorbent and retentive powers for water, and their dark colour is favourable to the absorption of heat. Moreover, the large amount of zeolitic matter they contain gives them powerful absorptive powers for many kinds of plant food, and renders them very thankful for rich manuring.

In general manuring, cropping, and cultivation the Japanese farmer has but little to learn from the European, but rather the converse; he fails, however, in knowledge of special manures, and the smallness of his holdings prevents many improvements in implements, and in other ways.

The analyses of soils given by Dr. Korschelt show a gradual decrease of combined nitrogen from the surface soil downwards in a very interesting manner. In one series taken at different depths the nitrogen in the top layer 25 centimetres is very large in amount, being 0.521 per cent, and decreasing steadily, till at 1 metre depth it is but 0.131 per cent. In another series the surface soil contains 0.372 per cent, which decreases to 0.095 at one and a half metres depth. In another the decrease is from 0.208 to 0.08 per cent; and again, in a fourth series, from 0.396 at the surface to 0.124 per cent of nitrogen at the depth of one metre. When we remember that 0.1 per cent in such a soil means 3000 lbs. of combined nitrogen in one acre to the depth of one foot, the immense stores of nitrogen in the soils are realised.

The percentage of carbon in the soils from Saitama is also very high, and the ratio between the amount of carbon and that of the nitrogen is higher than has been found in most soils.

What is most needed in Chemical Laboratories?—

J. Bing.—The author's answer to this question may be summarised in two words—efficient ventilation.—*Journal für Praktische Chemie*.

INFLUENCE OF PEPTONES AND CERTAIN
INORGANIC SALTS ON THE DIASTATIC
ACTION OF SALIVA.

By R. H. CHITTENDEN and J. S. ELY.
(Concluded from p. 182).

Influence of Peptones in Acid Solution.

PREVIOUS experiments* have plainly demonstrated the extreme sensitiveness of the saliva to the action of dilute acids. Thus the addition of 50 c.c. of 0.05 per cent hydrochloric acid to a digestive mixture, thereby making the fluid contain but 0.025 per cent of acid, very greatly diminishes the diastatic action. This result has been recently verified by J. N. Langley,† as also the results of Chittenden and Griswold in regard to the destruction of the salivary ferment by gastric juice and by 0.2 per cent hydrochloric acid at 40° C.

An attempt was now made to ascertain the influence of peptones in an acid solution of the above strength, viz., 0.025 per cent. The experiments were conducted in the same manner as the preceding, with this exception: the peptones, instead of being dissolved in water, were in each case dissolved in 50 c.c. of 0.05 per cent hydrochloric acid. 1 gm. of peptones was used in each experiment, starch being the amylaceous material employed.

Saliva alone.		Saliva and Acid.		Saliva, Acid, and Peptones.	
Wt. Cu in one-tenth. Grm.	Total amount of sugar. Grm.	Wt. Cu in one-tenth. Grm.	Total amount of sugar. Grm.	Wt. Cu in one-tenth. Grm.	Total amount of sugar. Grm.
1. 0.0896	0.4557	0.0076	0.0389	0.1068	0.5428
2. 0.0911	0.4633	0.0079	0.0405	0.1070	0.5439
3. 0.0915	0.4654	0.0098	0.0502	0.1060	0.5388
4. 0.0835	0.4247	—	—	0.0985	0.5010

The percentage amounts of starch converted into sugar under the three conditions are as follows:—

Saliva alone.	Saliva and Acid.	Saliva, Acid, and Peptones.
1. 41.01 per cent.	3.50 per cent.	48.85 per cent.
2. 41.69 "	3.64 "	48.95 "
3. 41.88 "	4.51 "	48.48 "
4. 38.22 "	—	45.09 "

Similar experiments were tried with glycogen, 2 grms of this substance being dissolved in 25 c.c. of water and employed in the same manner as the starch; 1 gm. of peptones was used as before. The following results were obtained:—

Saliva alone.	Saliva and Acid.	Saliva, Acid, and Peptones.
Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.
1. 0.1300 gm.	0.0049 gm.	0.1408 gm.
2. 0.1281 "	trace	0.1424 "

It is thus seen that the presence of 1 gm. of peptones exercises a very remarkable influence on the diastatic action of saliva in an acid solution of the above strength. The peptones are present in the digestive mixture to the extent of only 1 per cent., while the acid is but 0.025 per cent, yet this quantity of peptones is sufficient not only to counteract the retarding influence of the acid, but increases the conversion of the starch to the extent of 7 per cent above the action of the saliva alone. Increasing the amount of peptones to 2 per cent does not appear to have any effect whatever, as the following results show:—

1 gm. Peptones and 0.025 per cent Acid.	2 grms. Peptones and 0.025 per cent Acid.
Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.
1. 0.1060 gm.	0.1084 gm.
2. 0.0985 "	0.0974 "

In acid solutions of increased strength the peptones appear to exercise but slight if any influence; thus when the solution contained 0.1 per cent hydrochloric acid, no diastatic action at all was observed, even in the presence of the peptones. In 0.05 per cent acid solution, however, one-tenth of the diluted and mixed digestive fluid yielded 0.013 gm. Cu, showing a slightly increased action over and above what the acid fluid alone would give.

Control experiments with saliva, peptones, and acid without starch yielded negative results, thus showing that the saliva is entirely without action on the peptones in an acid solution of the above strength. Again, digestions of starch, peptones, and acid without saliva also gave negative results, proving that the peptones are wholly without diastatic action in the acid fluid. We deemed it advisable next to examine how far inorganic salts could influence the action of the ferment in an acid solution of the strength used. In aqueous solution it will be remembered the inorganic salts experimented with had but little or no action. In the acid solution the salts used were the same as before, viz., those present in the ash of the peptones. The experiments were conducted in the same manner as the preceding; 100 c.c. being the volume of the mixed fluid, of which 25 c.c. were filtered saliva, 25 c.c. water containing 1 gm. of starch, and 50 c.c. 0.05 per cent hydrochloric acid containing the salt.

FIRST EXPERIMENT.

Saliva and starch alone	Wt. Cu in one-tenth. Grm.
" " + 0.05 per cent HCl = 0.025 per cent	0.0872
" " " " + 0.012 gm. NaCl	0.0132
" " " " + 0.012 gm. Na ₂ HPO ₄	0.0120

SECOND EXPERIMENT.

Saliva and starch alone	Wt. Cu in one-tenth. Grm.
" " + 0.05 per cent HCl = 0.025 per cent	0.0835
" " + 0.05 per cent HCl + 0.012 gm. CaHPO ₄	0.0050
Saliva and starch, + 0.05 per cent HCl + 0.012 gm. CaHPO ₄	0.0079
Saliva and starch, + 0.05 per cent HCl + 0.015 gm. CaHPO ₄	0.0490
Saliva and starch, + 0.05 per cent HCl + 0.024 gm. CaHPO ₄	0.0600

It is thus evident that sodium chloride and phosphate when present to the extent of 0.012 per cent exercise but a very slight influence on the action of the saliva. Calcium phosphate, however, is seen to decidedly increase the diastatic action, though the amount contained in the peptones can have but little influence on the formation of sugar. Very striking is the great increase of sugar formed in the presence of 24 milligrams of calcium phosphate. This result is certainly suggestive of a possible utility of the calcium phosphate invariably present in wheat, oats, and carbohydrate matter in general. What the exact explanation of the action of the phosphate in such a weak acid solution is of course hypothetical. The salt dissolves, in part at least, in the acid, and is thus probably modified with formation of bodies more favourable to the action of the ferment; it certainly cannot diminish to any extent the strength of the acid.

The influence of the combined inorganic matter of the peptones was now determined by experiment with the ash of No. 1, which contained 1.71 per cent.

Saliva and Starch.	+ 0.05 per cent HCl.	+ 1 gm. Peptone.	+ Ash 1 gm. Peptone.
Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.	Wt. Cu in one-tenth. Grm.
1. 0.0866 gm.	0.0053 gm.	0.1058 gm.	0.0370 gm.
2. 0.0862 "	—	—	0.0123 "

Thus, in the sample containing the largest percentage of ash, and presumably therefore of calcium phosphat

* Chittenden and Griswold, *American Chemical Journal*, 3, 313.
† *Posters' Journal of Physiology*, 3, 246.

and under the same conditions as this salt appears to work to the best advantage, only a slight increase is noticed in the diastatic action of the saliva. It is therefore evident that while the addition of 50 c.c. 0.05 per cent hydrochloric acid to an equal volume of saliva and water brings the diastatic action down almost to zero, the addition of 1 gm. of peptones to this acid fluid increases the diastatic action of the saliva to above its normal amount. In other words, the presence of 1 per cent of gastric peptones in a salivary mixture containing 0.025 per cent of acid acts as a stimulant to the diastatic ferment, causing it to act with greatly increased vigour. This fact appears to us to be of prime importance in solving the question as to the possibility of a continued action of the salivary ferment in the stomach. In 1881 one* of us, experimenting with human saliva, found that its diastatic action was increased by the presence of very minute quantities of hydrochloric acid; thus, while the quantity of sugar formed by freshly collected saliva was regarded as 100, the quantity formed by saliva of the same collecting in a mixture containing 0.005 per cent of hydrochloric acid was 110. Increasing the percentage of acid diminishes the diastatic action, until at last, when the fluid contains 0.025 per cent of hydrochloric acid, the formation of sugar is almost entirely stopped. Again, it was found† on digesting 25 c.c. of human saliva with 50 c.c. of gastric juice containing 0.2 per cent of hydrochloric acid, at 40° C. for two hours, that the diastatic ferment was entirely destroyed; likewise that simple warming of the saliva with 0.2 per cent acid at 40° C. for two hours was sufficient to destroy the greater part of the ferment, as was evinced by the low diastatic power of the neutralised fluid. Both of these results have received recent confirmation from the experiments of J. N. Langley‡ on the diastatic ferments of the parotid of rabbits. From his experiments he concludes that the ptyalin is destroyed by 0.2—0.04 per cent hydrochloric acid in from 7 to 24 hours at 40° C., and that the presence of 0.014 per cent of acid is sufficient to destroy all but the merest trace of ferment for five minutes at 39° C. It appears to us, however, that in the case of human saliva at least there may be in the presence of a very dilute acid a simple stopping of the diastatic action without destruction of the ferment; thus, in the presence of 0.025 per cent of acid there is but little diastatic action, but if that percentage of acid is sufficient to destroy the ferment in such a short time, in what manner does the 1 per cent of peptones in an acid solution of the same strength cause such an increased formation of sugar? Again, the experiments of Chittenden and Griswold showed that by warming a mixture of starch, saliva, and artificial gastric juice of weak acidity at 40° C. for 45 minutes, the diastatic action of the saliva was greatly increased; thus, in the digestion of 1 gm. of starch + 25 c.c. of water + 50 c.c. of gastric juice, containing 0.5 per cent hydrochloric acid + 25 c.c. saliva, the amount of sugar formed as compared with the amount found by the saliva alone was 133 : 100; while, as the present experiments show, the presence of 0.025 per cent hydrochloric acid alone stops the action almost completely. It therefore seems probable that in the presence of such dilute acids as the above the ferment is simply hindered in its action, the presence of the peptones being sufficient to counteract the retarding influence of the acid. That this view, as to the non-destruction of the ferment is correct, as regards human saliva at least, we think is plainly demonstrated by the following experiment. 75 c.c. of filtered saliva were divided into three equal parts, which were treated as follows:—

1st. 25 c.c. saliva + 25 c.c. 0.05 per cent HCl warmed at 40° C. for 45 minutes. Solution then neutralised with Na_2CO_3 . 1 gm. of starch made into a paste with 50 c.c. H_2O was then added and the mixture warmed at 40° C. for 45 minutes. Solution boiled and diluted to 500 c.c. 50 c.c. of this solution reduced 0.0862 gm. Cu.

2nd. 25 c.c. saliva + 25 c.c. H_2O + 50 c.c. 0.05 per cent HCl warmed at 40° C. for 45 minutes. Solution then neutralised with Na_2CO_3 . 1 gm. of starch made into a paste with 25 c.c. H_2O was then added and the mixture warmed at 40° C. for 45 minutes. Solution boiled and diluted to 500 c.c. 50 c.c. of this solution reduced 0.0805 gm. Cu.

3rd. 25 c.c. saliva + 75 c.c. H_2O warmed at 40° C. for 45 minutes. 1 gm. of starch made into a paste with 25 c.c. H_2O was then added and the mixture warmed at 40° C. for 45 minutes. Solution boiled and diluted to 500 c.c. 50 c.c. of this solution reduced 0.0824 gm. Cu.

Here it is plainly seen that the ferment has not been in the least affected by the action of 0.025 per cent hydrochloric acid at this temperature. In the case of 0.1 or 0.2 per cent acid the peptones are wholly without influence, since these strengths of acid are capable of destroying the ferment. It is evident that the salivary ferment is ultimately destroyed in the stomach by the gastric juice, but this fact does not necessarily preclude the possibility of a continued action of the saliva in the stomach. There is a growing impression that in the first stage of stomach digestion there is but little or no free acid present; thus Reinhard v. d. Velden† claims, as a result of observation, that for the first three-fourths of an hour after eating a hearty meal, human gastric juice fails to contain much if any free acid. It now seemed desirable to ascertain the rapidity with which starch is converted into sugar by the saliva. 125 c.c. of filtered saliva were thoroughly mixed, and 12 c.c. of this fluid were used in each experiment. The starchy solution was made by boiling 0.5 gm. of starch with 40 c.c. of water, and to this solution the 12 c.c. of saliva were added, making approximately 52 c.c. of fluid. The mixtures were kept at a temperature of 40° C. for the specified time, then boiled to destroy the ferment. Each fluid was then diluted to 200 c.c. and the sugar determined as before in 50 c.c. of the mixed and filtered solution. Following are the results:—

Period of digestion.	Wt. Cu in one-fourth.	Total amount of sugar.	Percentage of starch converted into sugar.
1 minute	0.0870 gm.	0.4425 gm.	39.82 per cent.
5 minutes	0.0963 "	0.4898 "	44.09 "
10 "	0.0991 "	0.5040 "	45.36 "
15 "	0.1005 "	0.5111 "	45.99 "
30 "	0.1040 "	0.5286 "	47.57 "
45 "	0.1087 "	0.5525 "	49.72 "
1 hour	0.1109 "	0.5637 "	50.73 "
2 hours	0.1147 "	0.5842 "	52.57 "

This experiment makes it very apparent that by far the greater part of the starch is almost immediately converted into sugar. It seems therefore quite possible, especially in view of the action of peptones in a weak acid solution, that in the case of human beings there may be a continuation of salivary digestion in the stomach, provided the contents of the stomach during the first stage of digestion do not contain more than 0.025 per cent of free acid.

Influence of Peptones in Alkaline Solution.

Previous experiments have demonstrated that the addition of sodium carbonate to saliva has a retarding influence on salivary digestion. It now seemed advisable to study the influence of peptones in the presence of dilute solutions of sodium carbonate, with especial reference to

* It should be mentioned here that the real percentage of acid is somewhat less than 0.025, owing to the slight alkalinity of the saliva. Ordinarily, however, the alkalinity is not so great in a sample of several hundred cubic centimetres as in a small quantity of freshly secreted saliva. That there might be no possible chance of error, 25 c.c. of mixed saliva were carefully neutralised with diluted hydrochloric acid. Then 25 c.c. of 0.05 per cent HCl were added, making an exactly 0.025 per cent HCl solution. This mixture was then warmed at 40° C. for 45 minutes, after which it was exactly neutralised with Na_2CO_3 solution. 1 gm. of starch in 50 c.c. H_2O was then added and the whole warmed at 40° C. for 45 minutes; 50 c.c. or one-tenth of the diluted fluid yielded 0.0882 gm. Cu. Thus here, as in the above experiments, it is plainly evident, from the diastatic action of the neutralised saliva, that the ptyalin is not destroyed or even affected by 0.025 per cent of actual HCl under the above conditions.

† *Zeitsch. f. physiol. Chem.*, 3, 205.

* Chittenden and Griswold, *American Chemical Journal*, 3, 305.

† Chittenden and Griswold, *loc. cit.*

‡ Foster's *Journal of Physiology*, 3, 246.

the pancreatic ptyalin, for presumably in the intestinal canal the diastatic ferment there present acts on starch in an alkaline medium. 0.6 per cent, 0.3 per cent, and 0.1 per cent solutions of sodium carbonate were employed, experiments being tried with both starch and glycogen. 1 gram. of peptones was used in each case, and as this amount was dissolved in 50 c.c. of the dilute alkali, the digestive mixture of 100 c.c. contained approximately one-half the percentage of alkali employed. The following results were obtained:—

1.—With 0.6 per cent Na_2CO_3 and 1 gram. peptones.

	Saliva alone. Wt. Cu in one-tenth.	Saliva + 50 c.c. Alkali. Wt. Cu in one-tenth.	Saliva, Alkali, and Peptones. Wt. Cu in one-tenth.
Starch	0.0905 grm.	0.0239 grm.	0.0456 grm.
"	0.0904 "	0.0222 "	0.0486 "
"	0.0835 "	0.0214 "	0.0515 "
Glycogen	0.1300 "	0.0312 "	0.0683 "

2.—With 0.3 per cent Na_2CO_3 and 1 gram. peptones.

	Saliva alone. Wt. Cu in one-tenth.	Saliva + 50 c.c. Alkali. Wt. Cu in one-tenth.	Saliva, Alkali, and Peptones. Wt. Cu in one-tenth.
Starch	0.0904 grm.	0.0393 grm.	0.0685 grm.
"	0.0835 "	0.0331 "	0.0710 "
Glycogen	0.1281 "	0.0423 "	0.1050 "

3.—With 0.1 per cent Na_2CO_3 and 1 gram. peptones.

	Saliva alone. Wt. Cu in one-tenth.	Saliva + 50 c.c. Alkali. Wt. Cu in one-tenth.	Saliva, Alkali, and Peptones. Wt. Cu in one-tenth.
Glycogen	0.1281 grm.	0.0908 grm.	0.1197 grm.

It becomes evident then from these experiments that in a solution containing either 0.3 per cent or 0.15 per cent of sodium carbonate, the presence of the peptones nearly doubles (quite and even more in the case of glycogen) the diastatic action, bringing it up almost to the action of the unaltered saliva. It may be questionable whether these experiments afford proof positive that the peptones stimulate the pancreatic ferment in the conversion of starch into sugar in the intestinal canal, but it is certainly proven that under such conditions as have been described here, the presence of 1 per cent of peptones in a 0.3 per cent sodium carbonate solution causes a greatly increased formation of sugar. Thus it seems probable that in the proteid and diastatic pancreatic digestion the formation of peptones, which must go on side by side with the formation of sugar, affords a decided aid to the latter process.

We next endeavoured to ascertain whether the salts already experimented with have any influence on diastatic action in alkaline solutions of the strength specified. The following experiments were tried:—

FIRST EXPERIMENT.

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone	0.0872
" " + 50 c.c. 0.6 per cent Na_2CO_3 = = 3 per cent alkali	0.0220
Saliva and starch, + 50 c.c. 0.6 per cent Na_2CO_3 + + 0.012 grm. NaCl	0.0287
Saliva and starch, + 50 c.c. 0.6 per cent Na_2CO_3 + + 0.012 grm. Na_2HPO_4	0.0275

SECOND EXPERIMENT.

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone	0.0844
" " + 50 c.c. 0.6 per cent Na_2CO_3 = = 0.3 per cent alkali	0.0225
Saliva and starch, + 50 c.c. 0.6 per cent Na_2CO_3 + + 0.015 grm. CaHPO_4	0.0211
Saliva and starch, + 50 c.c. 0.3 per cent Na_2CO_3 = = 0.15 per cent alkali	0.0348
Saliva and starch, + 50 c.c. 0.3 per cent Na_2CO_3 + + 0.015 grm. CaHPO_4	0.0395

It is thus very evident that these salts have little or no influence on diastatic action, in alkaline solutions of the strength used. It next remained to try the influence of the ash of the peptones in alkaline solution. The ash of 1 gram. of peptones was employed, the experiment being conducted in the same manner as the preceding. The peptones used were those with 1.71 per cent of ash. Following are the results:—

	Wt. Cu in one-tenth. Grm.
Saliva and starch alone	0.0862
" " + 50 c.c. 0.6 per cent Na_2CO_3 = = 0.3 per cent alkali	0.0216
Saliva and starch, + 50 c.c. 0.6 per cent Na_2CO_3 + + ash 1 gram. peptone	0.0313
Saliva and starch, + 50 c.c. 0.6 per cent Na_2CO_3 + 1 gram. peptone	0.0520
Saliva and starch, + 50 c.c. 0.3 per cent Na_2CO_3 = = 0.15 per cent alkali	0.0305
Saliva and starch, + 50 c.c. 0.3 per cent Na_2CO_3 + + ash 1 gram. peptones	0.0400
Saliva and starch, + 50 c.c. 0.3 per cent Na_2CO_3 + + 1 gram. peptone	0.0740

We therefore deem it safe to conclude that the inorganic salts contained in the peptones play but an unimportant part in the stimulating action noticed in an alkaline solution of the strength specified.—*American Chemical Journal*.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY
SAMPLES OF THE WATER SUPPLIED TO LONDON,
FOR THE MONTH ENDING SEPTEMBER 30TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOOT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE
LOCAL GOVERNMENT BOARD.

Oct. 2nd, 1882.

SIR,—We submit herewith the results of our analyses of the 181 samples of water collected by us during the month of September, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 181 samples, one was recorded as very slightly turbid. The remaining 180 samples were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from Sept. 1st to Sept. 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

Altogether, the results of our analyses of the 181 samples of water, examined by us during the past month, show a continuance of the excellent condition of the water supply of the Metropolis which we have remarked upon in our previous monthly reports.

As regards the systematic examination of the condition of aeration of the water, to which we attach great im-

tance as an indication of its state of wholesomeness, we would observe that determinations of this condition are, at present, made and recorded only by ourselves.

As regards the determination of colour, we take it as beyond question that the method of examination employed and originated by ourselves, however susceptible it may be of further improvement, is far more trustworthy and accurate than the rough method heretofore, and still, made use of by chemists in general.

As regards the determination of turbidity, we cannot advance any special claim on behalf of the admittedly rough and imperfect method of examination employed by ourselves in common with other chemists. It is, however, satisfactory for us to find that our results, in respect to the habitual freedom from turbidity of the water, are thoroughly in accordance with those of the official Water Examiner, Colonel Bolton. Moreover, any defects, in regard either to colour or turbidity of the water supplied to the public are matters that come necessarily within the immediate cognisance of the public.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

THE PATENT VACUUM-PUMP REFRIGERATOR AND ICE-MACHINE.

ON the 13th inst. a number of scientific gentlemen met at the premises of the Aylesbury Dairy Company, 31, St. Petersburg Place, Bayswater, to witness the action of a machine which is, we believe, destined, from a twofold point of view, to open up a new epoch in chemical industry, and which is eminently deserving of the attention of manufacturers, capitalists, as well as of men of science.

The more immediate object of the invention is the production of ice, the refrigeration of water, &c. This purpose it effects more conveniently, simply, and cheaply than any arrangement hitherto known. We need scarcely remind our readers that in modern manufacturing chemistry, no less than in the refined operations of the laboratory, a complete command of temperature is necessary. High temperatures have been always easily producible, but to keep up a low temperature on the large scale and for any required time has been a troublesome and expensive matter. There are not a few refrigerating machines in existence, but these depend for their action on the evaporation of certain volatile liquids, such as ammonia, sulphurous anhydride, ether, methyl chloride, carbon disulphide, &c. To all these and to analogous agents there are grave practical objections. The first outlay is considerable, their recovery and condensation involve much cost and inconvenience, especially in hot climates or seasons where a refrigerating machine is most needed. If even a trace of these volatile chemicals escapes there results either damage to the machinery, injury to the health of the workmen, or deterioration of the product.

In the machine in question the refrigeration is effected simply by the evaporation of water under a special vacuum-pump, by which the pressure of the air is reduced, if desired, even down to $\frac{1}{4}$ millimetre ($= \frac{1}{1175}$ atmosphere), a more perfect vacuum than has heretofore been obtained on an industrial scale. In ice-making a considerably less perfect vacuum (say $\frac{1}{4}$ millimetres absolute pressure, or $\frac{1}{1175}$ atmosphere) is found sufficient. The only chemical required in the process is sulphuric acid, which is not dissipated or evaporated, and never comes in contact with the refrigerating part of the machine. Hence it neither requires renewal nor occasions injury.

The construction and action of the machine will be more

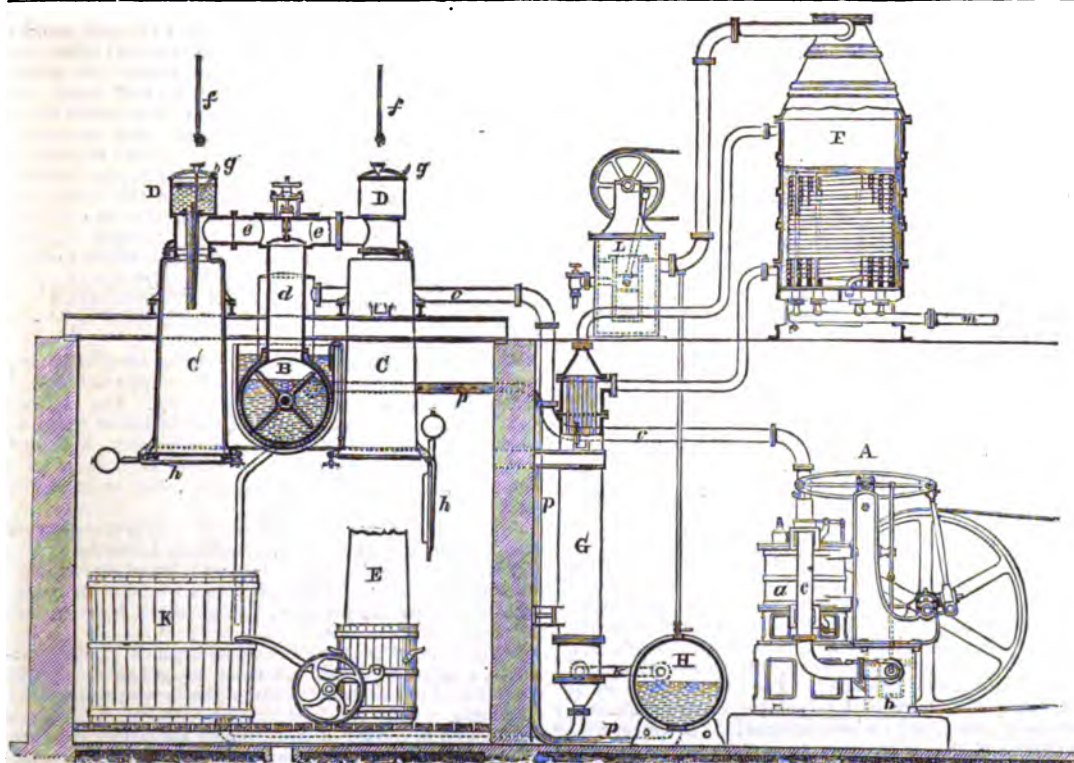
easily understood by reference to the accompanying figure. The working of the process will be found strikingly economical. A machine which turns out 12 tons of ice per twenty-four hours requires only one man at a time to work it, and for the production of this quantity rather less than a ton of coal—or, more exactly, 180 lbs. per ton of ice—is consumed. There is no need for any large supply of water for cooling—a very important point on board ship and in countries where water is scarce. The average power needed for working a single machine does not exceed 3 h.-p., and taking all expenses into account, with interest on capital and 10 per cent for depreciation, the cost of the ice will not exceed 3d. (threepence) per cwt.

The scope for such a machine is simply immense. In addition to the production of ice,—now the subject of an extensive commerce,—we may briefly mention the transportation of meat, game, fish, milk, vegetables, &c., to any desired market from the most distant parts of the world. It is found that this may be effected by means of cold air far more safely and with less injury to the flavour, digestibility, and nutritive value of the articles than by any other means. Further, the command of a low temperature, effected, e.g., by ice-cold water conveyed in pipes traversing the liquid, is of great value in the cooling of worts, in regulating the fermentation of beer and of wine in hot localities, in the manufacture of chocolate, where too high a temperature is very injurious. Certain doubt's decompositions can further be effected best at a low temperature. Thus, under Fournier's patent a mixture of brine and of the lixivium of alum-shales yields at a little below freezing-point crystals of Glauber's salt, whilst aluminium chloride (useful as a disinfectant and in the destruction of vegetable matter mixed with wool) remains in solution. Magnesium chloride is obtained in like manner by refrigerating brine mixed with the mother-liquor of salt-marshes.

In the new or ammonia-process of alkali-making which is now coming to the front the solution of common salt employed when saturated with ammonia generates much heat, and requires to be cooled by a refrigerating apparatus. In the preparation of certain tin mordants, such especially as the so-called "bowl-spirits," it is in hot weather necessary to be able to regulate the temperature. In the preservation of albumen refrigeration is of capital importance during its purification.

The manufactures of nitroglycerin, gun-cotton, and all analogous bodies also require convenient and powerful means of refrigeration. The mixture of sulphuric and nitric acids must be cooled after mixture, and when it comes to act upon the glycerin, cotton, &c., a rise of temperature is apt to deteriorate the product, if not to occasion positive danger. In all these manufacturing processes, and in others which might be found upon a prolonged search, the Vacuum Ice-Machine and Refrigerator must, from its economy, simplicity, and freedom from objectionable features, fairly claim the attention of manufacturers.

There is still a second phase in the invention, perhaps of not less importance. The vacuum-pump may be used not for refrigeration or the production of ice, but wherever it is required to boil, concentrate, or distil any liquid, paste, &c., under reduced atmospheric pressure, or as far as possible in the total absence of air. Perhaps the first case in which boiling *in vacuo* was introduced is the manufacture of sugar. On prolonged heating even at temperatures not exceeding 212° F., a part of the sugar is converted into glucose containing more or less caramel, and forming the liquid known as treacle or molasses, a substance of much less commercial value than pure cane-sugar. The more the atmospheric pressure on the surface of the liquid is reduced the lower is the temperature at which its water evaporates and the smaller is the proportion of sugar converted into treacle. The principle of boiling under reduced pressure is equally applicable in the manufacture of jams or preserved fruits (now an important industry), of extracts of dye-woods, extracts of meat, medicinal woods, barks, &c. In all these cases, as a rule



- A.—Vacuum-pump. *a*, large cylinder; *b*, small cylinder; *c*, suction pipe from pump to absorber and freezing cylinders.
B.—The absorber, containing sulphuric acid, which is kept in motion by revolving arms, a vacuum being maintained. *d* and *e*, pipes connecting absorber with ice cylinders, the connection between *d* and *e* being controlled by valve at top of *d*.
C.—The cylinders in which the ice is formed.
D.—Vessels into which the water to be frozen first passes from the pipe *f*, before flowing into the cylinders, through the valve controlled by the lever *g*; *h* the lid or bottom of the ice cylinder which is opened so as to allow the ice to fall out.
E.—Block of ice.
F.—The concentrator, in which the acid is freed from the vapours absorbed during the passage of the water from D to C.

- G.—Exchange apparatus through which the dilute acid ascends to be concentrated and the concentrated acid descends to the store tank H, from which it can be drawn by the vacuum into the absorber as required. In the exchange apparatus the boiling concentrated acid is cooled during its descent by passing over and outside the pipes through which the cold dilute acid is descending.
H.—Tank into which the acid is received from the absorber after it has become diluted, and from which it is drawn into the concentrator.
L.—Small vacuum-pump for maintaining vacuum in the concentrator. *k*, pipe conveying concentrated acid to store-tank H.
M.—Steam pipe from boiler.
P.—Connection pipe between absorber and store tank H.

the product is more or less injured in colour, flavour, &c., by prolonged heating in presence of atmospheric oxygen. The more such oxygen is withdrawn and the atmospheric pressure reduced so as to allow of extraction at a lower temperature, the purer and the finer is the product.

There are also many substances which require to be dried, but which cannot well be exposed to heat without risk of deterioration. We may here mention explosives, and textile goods dyed with such colours as safflower. By means of the vacuum-pump such articles can be dried without any application of heat, and consequently without any risk of fire or deterioration.

In fractional distillation, as in the separation of the different coal-tar products, and more especially in the case of the heavier hydrocarbons, the use of a vacuum has a great future before it. According to Professor Lunge "excellent success" has been obtained in this matter in the separation of anthracen oil. In like manner glycerin can be advantageously purified by distillation under reduced pressure. Albumen will also be improved in quality by evaporation *in vacuo*. In all these cases the new pump, giving as we have already remarked a more perfect vacuum than has ever been obtained before, will be found a marked improvement.

We learn that the machine set up on the premises of

the Aylesbury Dairy Company will be available for experiments whether of a scientific or of an industrial character, and may be viewed on written application.

The Institute of Chemistry.—The first Provincial Dinner of the Institute of Chemistry was held at the Western Hotel, Birmingham, on Friday, the 20th inst., and was numerously attended both by members residing in and around this busy centre of chemical industry and by members from London. In replying to the toast of the evening, "Success to the Institute," proposed by Prof. Odling, the President, Prof. Abel, briefly traced its history. It was established to supply the want keenly felt by the chemical platform of an organisation to protect their interests. Its fundamental objects were the promotion of a thorough study of chemistry and the adoption of whatever measures might be necessary to advance the interests of the profession. A suitable course of training had been laid down after careful consideration, and the attainment of the grade of Member or Associate was gradually coming to be regarded as a proof of fitness for election to technical, professional, or official appointments. On Friday and Saturday the members visited Earl Dudley's Iron Works, Messrs. Chance's Alkali and Glass Works, The Mint, Gas Works, &c.

NOTES OF WORK BY STUDENTS OF
PRACTICAL CHEMISTRY
IN THE
LABORATORY OF THE UNIVERSITY OF
VIRGINIA.

No. XI.

Communicated by J. W. MALLETT,
Professor of General and Applied Chemistry in the University.

(76.) *On Arsenic Pentiodide.* By B. E. SLOAN, of Charleston, South Carolina.

A former student in this laboratory, Mr. Hampton, having ascertained the existence of a pentiodide of phosphorus and examined its chief properties,* Mr. Sloan undertook the attempt to produce a corresponding compound of arsenic, which if obtained would have connected with it the interest of additional evidence as to the true pentad character of this latter element. Mr. Sloan had previously endeavoured to prepare a pentachloride,† but without success.

635 parts of iodine and 75 of metallic arsenic ($=AsI_5$) were enclosed in a tube from which air had been expelled by carbon dioxide gas, sealed up, and exposed, surrounded by an iron tube to secure uniformity of temperature, to $150^{\circ}C.$ for an hour and a half. After slow cooling the tube was opened, and found to contain a garnet-brown crystalline mass with resinous lustre. Under the microscope this mass seemed to be homogeneous, and, although the crystalline form could not be distinctly made out, some of the facets exposed were suggestive of elongated prisms of monoclinic character. The substance fused at $70^{\circ}C.$, and was more or less soluble in water, alcohol, chloroform, ether, and carbon disulphide. Disintegration and change of appearance soon took place on exposure to moist air, the colour becoming lighter and more orange. A rough determination of specific gravity, made upon a small fragment of the mass coated with paraffin, gave as result 3.53. This may be too low, yet it is worthy of notice that the specific gravity of arsenic tri-iodide has also been found lower than that of either of its constituents, though to a less extent than in the experiment now quoted,‡ and the lowering of density observed as the result of combination of 1 at. arsenic with 3 of iodine will, if extended by calculation in the ratio 3 : 5, give just the result found by Mr. Sloan.

A specimen of the supposed pentiodide was sealed up in an atmosphere of nitrogen in a glass tube, and the end containing the solid material was heated to about $200^{\circ}C.$ The mass fused and boiled, deep reddish brown vapour was given off, and successive rings of deposit formed in the cooler part of the tube, that nearest the heated end having apparently the same character as the residual mass, while iodine had separated at the further end. After boiling for three minutes, on cooling and breaking the tube the residual mass was analysed, and afforded 632 pts. of iodine for 75 of arsenic; it hence had still essentially the composition of the pentiodide.

A new specimen was prepared, with a very small excess of arsenic over the theoretical amount (for AsI_5), and, having been sealed up in nitrogen as before, was gradually heated in one end of the tube to $100^{\circ}C.$, the other end being kept at about 20° . At 70° , the fusing-point of the compound, there was slight evolution of iodine vapour, but after seven hours at 100° only a trifling amount of iodine had been driven off, and had condensed in the cooler end of the tube. Dissociation was found to increase rapidly with further rise of temperature.

Iodine and arsenic were then fused together in other proportions, one lot containing 762 parts of iodine for 75 parts of arsenic ($=As+I_6$), and another 589 of iodine

for the same amount of arsenic ($=As+I_7$), and samples of the resulting products were heated in sealed tubes containing inert gases. A sample of the former was heated in a mercury bath at 190° for two and a half hours; the residual mass was found to contain 619.5 of iodine for 75 of arsenic. Another specimen of the same was kept for five hours at 190° : dissociation occurred to such an extent as to bring the amount of iodine in the residual mass down to 430 for 75 of arsenic. In this latter case the residual mass was seen under the microscope to consist of a mixture of the tri-iodide crystals with crystals, apparently unaltered, of the brown supposed pentiodide, distinguishable where thin enough by difference of behaviour in polarised light. In these two experiments it was noticed that iodine was expelled much more rapidly at first than afterwards.

Two other samples, one each of the samples having the composition $As+I_6$ and $As+I_7$, respectively, were heated for forty-five minutes only to 190° . The residual portions gave on analysis 639 and 641 of iodine for 75 of arsenic, agreeing very fairly with the formula AsI_5 , and thus showing that the iodine in excess of five atoms is lost much more readily than the two other atoms to be removed in reduction to AsI_3 .

A specimen of the tri-iodide itself was prepared, with even a slight excess of arsenic, and on being heated to $165^{\circ}C.$ in a closed tube, it too was found to undergo gradual dissociation, losing iodine to an increasing extent with increasing temperature, though much less so than the supposed pentiodide.

In the hope of securing individual crystals of the pentiodide, a solution of this substance in carbon disulphide was allowed to evaporate at atmospheric temperature in a desiccator. Only ruby-red crystals, which on analysis were found to consist of AsI_3 , mixed on further evaporation with crystals of iodine, were obtained. The pentiodide seems, therefore, to be decomposed by mere solution in carbon disulphide. This conclusion was confirmed by examining the absorption-spectrum of the solution, which was found to agree simply with the superposed spectra of separate solutions of arsenic tri-iodide and free iodine.* Like decomposition occurs on dissolving in ether: on passing dry ammonia into the solution, the white precipitate characteristic of the presence of the tri-iodide† is thrown down, the supernatant liquid remaining coloured by iodine.

It is remarkable that the fusing-point of the substance under notice was found to be close to $70^{\circ}C.$, while the tri-iodide fused at 119° , and iodine itself fuses at 114° . No other proportions of iodine and arsenic gave a fusing-point as low as 70° .

It seems fair to conclude that arsenic, as well as phosphorus, is capable of forming a true, though unstable, pentiodide, which is broken up by sufficient rise of temperature and by solution at least in certain liquids. It adds another illustration to the remarks of Professor Williamson on changes of atomic value under varying conditions of temperature, in his address to the Chemical Section of the British Association in 1881.‡

(77.) *On the Solubility of Iodine in Arsenic Trichloride.*

By B. E. SLOAN.

Having failed to prepare a compound of one atom of arsenic with five atoms of chlorine, but obtained one with five atoms of iodine, Mr. Sloan also tried to form an intermediate product containing both halogens by bringing together iodine and arsenic trichloride. No evidence could be obtained of combination in definite proportions, but the iodine was found to dissolve in the liquid chloride of arsenic when heated in sealed tubes, colouring it deeply, the amount taken up increasing rapidly with rise of temperature, and the surplus iodine separating out in

* CHEMICAL NEWS, vol. xlii., p. 180.

† *Ibid.*, vol. xli., p. 203.

‡ Bödeker (Die Beziehungen zwischen Dicht und Zusammensetzung bei festen und liquiden Stoffen, Leipzig, 1860, 26) found the sp. gr. of $AsI_5 = 4.39$, while that of $As = 5.73$, and of $I = 4.95$, all in the solid state.

* See the application of this method to distinguishing mixtures from chemical combination by Krüss—*Berichte d. Deutsch. Chem. Gesellschaft.*, xv., 1243.

† Bamberger and Philipp, *Ibid.*, xiv., 2643.

‡ As reported in CHEMICAL NEWS, vol. xli., p. 127.

large crystals on cooling. By using a large excess of iodine at first, stopping the cooling at different points of temperature, drawing off samples of the remaining solution, and decomposing these by an aqueous solution of sodium sulphite, determinations were made of the iodine, chlorine, and arsenic present, leading to the following results:—

100 parts of AsCl ₃ at 0° C. dissolve	8.42	parts of iodine.
" " 15 " "	11.88	" "
" " 96 " "	36.89	" "

(78.) *On attempts to produce Compounds of Carbon Tetrachloride with Hydrochloric Acid and with other Compounds of the Halogens.* By W. H. SEAMON, of Wheeling, West Virginia.

A passage in Mendeleeff's well-known paper on the "Periodic Law" of the chemical elements, to the effect that, while silicon tetrachloride combines with other chlorides and forms moderately stable bodies, the corresponding chloride of carbon does not seem to be capable of doing so, and that this remarkable difference deserves to be carefully studied, led to Mr. Seamon spending a good deal of time in attempts to obtain some evidence of such combining power on the part of the latter chloride. All, however, led to but negative results.

Pure carbon tetrachloride was treated with a current of pure, dry hydrochloric acid gas under atmospheric pressure and at various temperatures down to -20° C., definite portions of the liquid being afterwards decomposed by an alcoholic solution of potash, and the chlorine determined. Experiments of the same kind were also made with hydriodic acid. Potassium chloride and ammonium chloride, moreover, were placed with carbon tetrachloride in sealed tubes, and exposed to various temperatures, from -20° to +338° C., and the liquid afterwards examined. In no case was any evidence of combination observed, and the analytical results simply corresponded to the unaltered tetrachloride.

In Hannay's experiments on the limit of the liquid state,* very great pressure, extending up to more than 140 atmospheres, produced absorption of hydrogen gas by carbon tetrachloride, but it is said that "several bodies were formed by the action of the hydrogen, the action being capable of being pushed so far as to form chloroform." Hence it may have been that no compound of an atom of carbon with more than four other atoms was formed, but that hydrogen in part displaced chlorine, hydrochloric acid, or less probably chlorine, being formed and liquefied, or reduced to very dense gaseous form, under the pressure used.

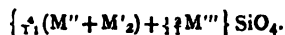
(79.) *Analysis of Allonite of Unusual Chemical Composition, from Bedford Co., Virginia.* By W. T. PAGE, of Norfolk, Virginia.

The specimen examined formed a compact black mass, with pitch like lustre, and light grey streak. Hardness = nearly 7. Sp. gr. = 4.32. Fusible before the blowpipe flame with intumescence. Completely decomposed by hydrochloric acid, forming a jelly. Analysis gave—

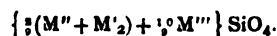
SiO ₂	26.70
Al ₂ O ₃	6.34
Ce ₂ O ₃	33.76
Di ₂ O ₃	16.34
La ₂ O ₃	1.03
Fe ₂ O ₃	3.21
FeO	4.76
MnO	trace
BeO	0.52
MgO	0.54
CaO	2.80
Na ₂ O	0.49
K ₂ O	0.55
H ₂ O	1.99

99.03

Excluding the water as unessential, these figures agree well with the ortho-silicate formula—



If beryllia be counted as Be₂O₃, there is not quite so close agreement with the formula—



The very large proportion of the cerium metals present, their oxides forming over 50 per cent of the whole mineral, or more than double the usual amount, and the large relative quantity of didymium as compared with lanthanum, are remarkable peculiarities in the composition of this mineral, and almost seem to justify its being considered at least a distinct variety. The ratio between the dyad and triad bases is quite different from that of ordinary allanite.

(80.) *Analysis of Helvite from near Amelia Courthouse, Virginia.* By B. E. SLOAN.

This rare mineral was identified by Prof. H. C. Lewis among the interesting contents of the granite vein worked for mica at the locality in question, and an analysis by Mr. R. Haines has been published.* The analyst remarks, however, that his material contained more than 9 per cent of gangue, that after subtracting this the results do not agree with those for helvite from the original European locality, and that a further investigation is desirable. A sufficient amount of the mineral from this State was obtained from Prof. Fontaine, of the University of Virginia, to admit of quite pure material being picked out for an analysis by Mr. Sloan.

The mineral was in fragile masses showing imperfect tetrahedral crystals. Colour wax to lemon yellow, with very pale lemon-yellow streak. Lustre vitreous. Translucent. Hardness = 6. Specific gravity = 3.25. Fusible before the blowpipe flame, with intumescence. Decomposed by hydrochloric acid, with formation of gelatinous silicic acid, and liberation of sulphuretted hydrogen. The analysis gave—

SiO ₂	31.42
BeO	10.97
MnO	40.56
FeO	2.99
Al ₂ O ₃	0.36
Mn	8.59
S	4.9

99.88

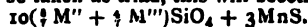
If beryllium be taken as dyad, and the small quantity of aluminum be neglected, these figures lead nearly to the formula adopted by Rammelsberg—



or more accurately to—



If beryllium be taken as triad, this will become—



If the sulphur be viewed as replacing oxygen, a disilicate formula would be indicated, but none can be calculated to accord well with the above figures.

(81.) *Analysis of Garnet from the same locality (near Amelia C.H., Va.).* By W. H. SEAMON.

This mineral was pale hyacinth-red, with colourless streak. Lustre vitreous. Transparent in small fragments. Hardness = 6.5. Sp. gr. = 4.27. Analysis gave—

SiO ₂	32.83
Al ₂ O ₃	16.69
MnO	41.80
FeO	8.15
Loss on ignition	0.61

100.08

* *Proceedings of the Royal Society*, No. 218, 319 (March 10, 1882).

* *Proc. Acad. Nat. Sci. Philadelphia*, 1882, 100.

Leading approximately to the general garnet formula, but with a deficiency of triad as compared with dyad metals, which would suggest that the iron or manganese, or both, occur in the former instead of the latter condition. Mr. Seamon, however, believed that he correctly determined these metals as exclusively in the state of ferrous and manganous silicates, and it is observable that the other recorded analyses* of this variety of garnet—spessartite, or aluminum-manganese garnet—from other localities agree in presenting the same anomaly.

(To be continued.)

CORRESPONDENCE.

SAFETY CHEQUES.

To the Editor of the Chemical News.

SIR,—There are three little fragments of old-fashioned wisdom which our inventors and improvers would do well to bear in mind. The first of these is to let well alone and not to insist on gilding refined gold. The second is to count the cost of a process. In experimenting upon the small scale amateurs, especially, are apt entirely to overlook every item of outlay except the mere cost of materials. They forget that every additional manipulation when we come to work upon an industrial scale increases and often doubles the cost of labour, of supervision, and in addition the chances of misadventure. The third consideration is that success, if too dearly bought, differs little from failure.

Of these principles I have been strongly reminded of late by a certain proposed method of obtaining cheques which cannot be tampered with before presentation. The reader will remember that in the beginning of last year you noticed an invention by Mr. A. Anthony Nesbit, F.C.S., which effects this object in a manner which combines certainty with simplicity and economy. Ordinary paper which requires no special manufacture is tinted with neutral litmus, with eosine, or with any other colour capable of being modified both by acids and alkalies, but in different manners. Upon this the inventor prints with a dilute acid producing red characters, lines, or other devices. By again printing with an alkaline liquid he produces blue lines, &c., interwoven with the first. The cheque is then ready for use, and is absolutely impregnable.

A Mr. Nowlan, however, forgetting the three principles above laid down, has obtained a patent for a much more complicated method of attaining the same end. He takes two or more pieces of thin paper, prints one side of each with pigments or reagents partly permanent and partly alterable, and then pastes them together with the printed side inwards, so that the devices, designs, or letters have to be read *through* the paper.

I have never had the pleasure of seeing one of these compound cheques, but even assuming that it affords absolute security against fraudulent alterations, it is merely on a level in this respect with Mr. Nesbit's cheque, whilst the trouble and expense of working under Mr. Nowlan's system must be two or three times as great. Instead of printing one piece of paper, two or three have to be operated upon, each with a different design or part of a design, and have then to be cemented neatly and accurately together without smudging any of the alterable pigments and making them run!

Surely there is no room for any practical man to ask which invention will prove the cheaper and the more convenient. Mr. Nowlan may reach his end, but it is by a cumbrous and round-about method.—I am, &c.,

CALICO-PRINTER.

* Compare analyses by Seybert, Rammelsberg, d'Ohsson, Lissenko, and Klaproth, quoted in Dana's "System of Mineralogy."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
July 20, 1882.

Contributions to the Industry of Vanadium.—G. Witz and F. Osmond.—The authors notice the presence of vanadium in many ores of iron. The vanadic acid is eliminated along with phosphoric acid, and is concentrated, especially in the slags of the Thomas and Gilchrist process. These slags in some cases contain 1.92 vanadic acid = 1.08 per cent metallic vanadium. They have observed that the vanadiferous slags, simply treated with hydrochloric acid, are successfully used in calico-printing instead of pure vanadic salts, the foreign matter present not interfering.

Certain Compounds of Tetratomic Elements.—Albert Colson.—Already noticed.

Specific Heat of Gaseous Acetic Acid.—MM. Berthelot and Ogier.—Already noticed.

Nitrogenous Colloids.—E. Grimaux.—The author remarks the excessive difficulty of defining what is meant by the proteic (albumenoid and collagenous) bodies, since their function is unknown. The definitions of these bodies found in text-books are merely based upon the totality of their physical properties. Their molecular weights are unknown, and it is uncertain whether the bodies isolated, such as albumen and fibrine, are true chemical individuals or merely mixtures. M. Grimaux proposes to define them as follows:—The proteic matters are nitrogenous colloids, which are split up by hydration into carbonic acid, ammonia, and amidic acid. Beyond this definition there is nothing precise; the coloured reactions do not belong to the albumenoid molecule, but depend on the various groups which enter their constitution. The red colour developed by Millon's reagent indicates a residue of the tyrosine group; the blue-violet colouration given by copper sulphate and potassa belongs equally to aspartic anhydride and to biuret.

Volumetric Determination of Phenol.—T. Chandelon.—The author uses a standard solution of potassium hypobromite, prepared as follows:—Dissolve 14 to 15 grms. of pure caustic potassa in 1 litre of water, and add about 10 grms. bromine in small quantities, stirring frequently. There is produced a golden-yellow liquid, which is diluted so that 50 c.c. may correspond to a 10 c.c. of a normal solution of phenol at 10.5 per cent, that is, to 0.05 gm. pure phenol. This liquid should be put into a blackened bottle and kept in a cold place. The determination is then effected as follows:—50 c.c. of the hypobromite solution are put in a Berlin ware capsule, and the solution of phenol is dropped in from a burette, stirring all the time, until the mixture is decolourised. After this point is reached, it is sufficient to add a few more drops of the phenol solution until the liquid loses the property of turning blue, a drop of iodised starch paste laid on a porcelain plate. The percentage is then found by dividing the figure 5 by the number of c.c. which have been employed.

Deutsch-Amerikanische Apotheker Zeitung.
Vol. iii., No. 12, September 1, 1882.

Volumetric Determination of Phenol.—The process depends on the precipitation of phenol by bromine as tribrom-phenol. Solutions of phenol of known strength are prepared by means of weighed quantities of pure phenol, and these solutions are dropped into a measured quantity of dilute bromine water until all the bromine is combined.

For the recognition of this point the author utilises a solution of starch containing some potassium iodide, which is placed upon a porcelain plate in small drops. As long as free bromine is present a drop added to the starch liquor gives the usual blue colouration, but as soon as all the bromine is taken up the colour no longer appears.

Journal für Praktische Chemie.

New Series. Vol. xxvi, Nos. 12, 13, and 14.

Occurrence of Lactic Acid in Morbid Urine and the Oxidation in the Tissues of the Leukæmic.—M. Nencki and N. Sieber.—Not suitable for abstraction.

MISCELLANEOUS.

Sewage Treatment.—An Agricultural and Horticultural Show open for all produce grown solely with the Native Guano obtained from the sewage of Aylesbury took place on the 19th inst. The numerous and distinguished visitors were much gratified both with the successful purification of the sewage, the entire freedom from nuisance throughout the works, and the fine display of vegetables and fruits exhibited. We could not help asking ourselves why, at sanitary gatherings, among the sentiments proposed and applauded we never hear the name of Dr. George Walker, once known as "Church-yard Walker"—the true father of modern sanitary reform? *Sic vos non vobis!*

Researches on the Specific Volumes of Liquid Compounds.—This treatise, which extends to upwards of 100 pages, consists of a general introduction by W. Lössen, and a special research on the specific volumes of certain allyl, propyl, and allied compounds, by A. Zander. The latter chemist concludes that the specific volume of the allyl compounds is decidedly greater than results if it is calculated from the specific volumes of the normal propyl compounds of analogous composition.—*Liebig's Annalen.*

NOTES AND QUERIES.

*. Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Estimation of Caustic Soda.—Can any correspondent recommend a rapid technical method of estimating small quantities of caustic soda in presence of carbonate and sulphide of sodium? The "phenacetolin" recently recommended does not answer, as far as we have tried it.—G. S.

MEETINGS FOR THE WEEK.

THURSDAY, Nov. 2nd.—Chemical, 8. "On some Halogen Compounds of Acetylene," by Dr. R. T. Plimpton. "On Dihydroxy-benzoic Acids and Iodo-salicylic Acids," by Dr. A. K. Miller. "Crystalline Molecular Compounds of Naphthalene and Benzene with Antimony Chloride," by Watson Smith and G. W. Davis. "Additional Evidence that Quinoline belongs to the Aromatic Series of Organic Substances," by Watson Smith and G. W. Davis. "On Orcin and some of the other Dioxy-toluols," by R. H. C. Neville and Dr. A. Winther.

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SESSION, 1882-83.

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Evening Courses.—Special Evening Course of Twenty-five Lectures on each of the following subjects, viz.:—Bleaching, Dyeing, and Printing, by Professor MILLS; Iron and Steel Manufacture, and Fuel, by Mr. J. SNODGRASS, Senior Assistant, are now in progress. These Lectures will qualify for the May Examinations of the City and Guilds of London Institute. Practical Evening Classes have also been commenced in connection with these Industries. For further particulars, see special Prospectuses.

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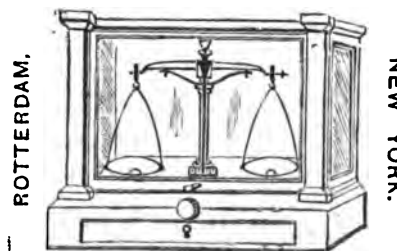
The Fee for attending the Laboratories is £20 per Session of Nine months, £14 10s. for Six months, £7 10s. for Three months, or £2 10s. per month. Students must have a fair acquaintance with elementary Chemistry.

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Glasgow, 128, Hope Street,
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ALEX. MOORE, C.A.,
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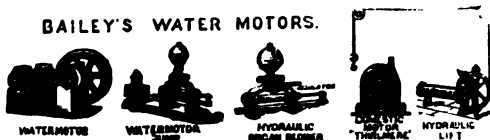
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THE CHEMICAL NEWS

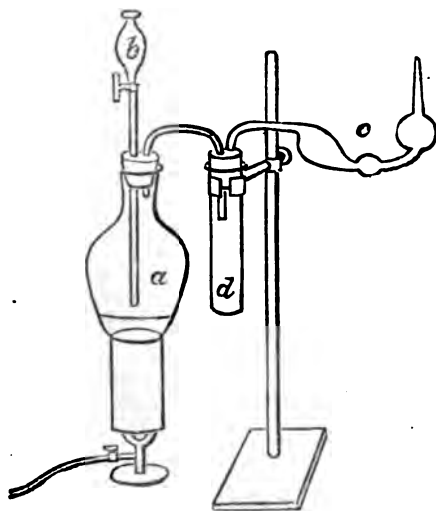
VOL. XLVI. No. 1197, 4 NOV 82

ESTIMATION OF SULPHUR IN IRON AND STEEL.

By GEORGE CRAIG.

For well nigh two years I have been estimating sulphur in iron and steel by a modification of the evolution process, which consists in passing the evolved gases through an ammoniacal solution of peroxide of hydrogen; which oxidises the sulphuretted hydrogen to sulphuric acid, which latter is estimated as usual. The *modus operandi* is as follows:—

100 grains of the iron or steel are placed in the 10 oz. flask (a) along with $\frac{1}{2}$ oz. water; $1\frac{1}{2}$ ozs. hydrochloric acid are added from the stoppered funnel (b) in such quantities at a time as to produce a moderate evolution of gas through the nitrogen bulb (c), which contains $\frac{1}{2}$ oz. (20 vols.) peroxide of hydrogen and $\frac{1}{2}$ oz. ammonia. The tube (d) is to condense the bulk of the hydrochloric acid which distils over during the operation. When all the acid has been added and the evolution of gas becomes sluggish, heat is applied and the liquid boiled till all action ceases. Air is blown through the apparatus for a few minutes and the contents of c and d washed into a small beaker and acidified with hydrochloric acid, boiled, barium chloride added, and the barium sulphate filtered off after standing a short time. A blank experiment must be done with each new lot of peroxide of hydrogen obtained, which always gives under 0.1 barium sulphate with me.



The whole operation is finished within two hours, the usual oxidation process occupying nearly two days; and the results obtained are invariably slightly higher than by the oxidation processes.

Until lately I have always added excess of chlorate of potash to the residue left in (a), evaporated it nearly to dryness, diluted, filtered and added chloride of barium to the diluted filtrate, but only once have I obtained a trace of precipitate after standing 48 hours, and the pig-iron in that case contained 8 per cent of silicon, so that all the sulphur is evolved during the process. It has been ob-

jected to the evolution process that when the iron contains copper all the sulphur is not evolved, but theoretically it ought to be evolved whether copper is present or not; and to test the point I fused 3 lbs. of ordinary Scotch pig-iron with some copper for half-an-hour in a Fletcher's gas furnace. No copper could be detected in the iron by mere observation with a microscope, but it gave on analysis 0.225 per cent of copper, and on estimating the sulphur in it by the above process and by oxidation with chlorate of potash and hydrochloric acid, using 100 grains in each case, and performing blank experiments, I found:—

By peroxide of hydrogen process .. 0.0357 per cent.

By oxidation (KClO₃ and HCl) „ .. 0.0302 „

so that even in highly cupriferous pig-iron all the sulphur is evolved on treatment with strong hydrochloric acid.

Lugar Iron Works,
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ON THE COLOURING MATTER (RUBERINE) AND THE ALKALOID (AGARYTHRINE) CONTAINED IN AGARICUS RUBER.

By Dr. T. L. PHIPSON, F.C.S., &c.

Agaricus ruber (*A. sanguineus*) is a poisonous fungus well known to botanists. It is perfectly described by Kickx in his "Flore Cryptogamique des Environs de Louvain," and by Chevallier ("Flore des Env. de Paris," tome i.), &c. I have found it growing profusely in the pine woods of the Hampshire coast, especially in the neighbourhood of Bournemouth, during the latter part of September and whole of October. It is readily distinguished by its burning taste, and its purple-red colour, which not only covers the pileus, but frequently coats a considerable part of the thick solid stipe, and is very different from the bright scarlet of *A. muscarius* and *A. Caesarius*.

This colouring-matter of *A. ruber*, for which I propose the name of Ruberine, is exceedingly interesting, both from an optical and a chemical point of view. It may be remembered that, a few years ago, I described under the name of Palmelline, a beautiful red colouring-matter extracted from *Palmella cruenta* (*Chaos sanguinea*), an account of which was published in the CHEMICAL NEWS.

This substance was remarkable, among other things, by its solutions showing a vivid yellow fluorescence, and by their giving dark absorption-bands in the yellow portion of the spectrum. Seen by transmitted light, palmelline is a beautiful rose-red, but by reflection it is yellow. The colouring-matter of *A. ruber* is no less remarkable in this respect. It is also a beautiful rose-red (very similar to palmelline) when seen by transmitted light, but it presents a very vivid blue fluorescence, and gives in its spectrum two wide and dark absorption-bands in the green.

Ruberine is soluble in water and in alcohol. A strong solution cuts off all the lower portion of the spectrum from the beginning of the green; but a weaker solution only shows the two very characteristic dark bands in the green part of the spectrum. Both the aqueous and alcoholic solutions present this character. These solutions are rose-red by transmission and blue by reflection. Their fluorescence, like that of palmelline solutions, is quite as marked (if not more so) as that of quinine or of esculine.

Several authors say that *A. ruber* is often found with its pileus more or less eaten "by insects." For a considerable time I could not discover what kind of animals eat this fungus, and suspected, from the extensiveness of the ravages, that some birds fed upon it. However, doubt in this respect was dispelled by discovering that the markings were due to slugs. Several of these mollusca I found feeding upon *A. ruber* at night and early morning and always on the summit of the pileus. The s-

lamellæ were always respected. The slugs eat through the colouring-matter and go to a certain depth into the substance of the fungus, but soon return to continue feeding on the coloured surface.

Fries, the great Swedish botanist, was right when he said that the taste of *A. ruber* is at first bitter, and then hot and pungent, like pepper. Whatever portion of the fungus is bitten gives at first a distinctly bitter taste, which is soon followed by a burning sensation, like that of pepper, and remaining some time upon the tongue. It is like the taste of aconitine, but not so intense.

All authors agree in stating that this fungus is extremely poisonous. The taste being due apparently to an alkaloid, I endeavoured to isolate this substance, and though the method I give below is very imperfect, it suffices to bring to light certain facts which appear to me rather interesting.

About 100 grms. of the freshly gathered fungus, from which the skin containing the purple-red colouring-matter had been removed as much as possible, were left for forty-eight hours in water acidulated by 8 per cent of hydrochloric acid. The solution, filtered and neutralised with a slight excess of carbonate of soda, was shaken up with ether. On evaporation, the ether left the alkaloid in the form of a white, or yellowish white, amorphous substance, somewhat greasy in aspect, having a distinctly bitter taste followed by a burning sensation on the tongue, a slight odour *sui generis*, easily fusible into pale yellow globules, and volatile with an odour recalling that of quinoline. It dissolves in alcohol and ether, and slowly but completely in dilute hydrochloric acid (in the cold). The sulphate appears to be quite insoluble in water, but dissolves in alcohol. With nitric acid the acid solutions take a rose-red colour, and the same occurs with chlorides of lime, with soon bleaches it. Also when, as above, the ether is shaken up with the liquid, air gets entangled and ozonified, acting on the alkaloid, which it transforms into this red colouring-matter, producing a thin red layer between the ether and the solution, so that some alkaloid is thus lost. With bichromate of potash and an acid solution of the alkaloid there is no reaction in the cold.

From these and other observations, too long to relate here, it appears to me very probable that the colouring-matter of *A. ruber* is formed from the alkaloid at those points of the fungus which are at the same time in contact with the air and the solar rays, i.e., the upper surface of the pileus and a good portion of the stipe. Also that both the alkaloid and colouring-matter belong to the aromatic series.

I propose for this alkaloid the name of *Agarythrine*, as it is well characterised by the red tint produced, as just stated, by nitric acid and hypochlorite of lime, as well as by its taste, which reminds us of aconitine, the insolubility of its sulphate in water, &c.

Ruberine being very easily soluble in water, it often happens that heavy rains of some days' duration wash it completely out of the head of the fungus, which then presents a peculiar bleached appearance.

London, October 31, 1882.

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS, late R.A.

II. ON A NEW BLOWPIPE REAGENT.

In the year 1880 Mr. Charles Griffin, of Garrick Street, was so kind as to obtain, at my request, absolutely pure boric and phosphoric acids from Germany. The latter, although very carefully sealed in a stoppered bottle, arrived in a semi-fluid state, and as it became quite fluid before the blowpipe, and dropped off the platinum wire, I found it impossible to make a bead of it. The so-called "glacial phosphoric acid" appears to be an extremely acid hydrated sodium (sometimes ammonium) phosphate, containing

about 15 per cent of soda, but exhibiting only acid reactions with oxides, &c., before the blowpipe.

(1.) I dissolved about two ounces of the pure phosphoric acid in distilled water, and digested in it, over a sandbath at a temperature just under boiling-point, pure crystallised boric acid, until, long before the former was saturated, crystals began to form; crystallisation proceeded rapidly after it had once commenced.*

(2.) I then poured off the superfluous liquor, and dried the crystals by placing the evaporating dish containing them vertically at side of the fire; when they seemed to lose crystallisation water, and to become earth-like, of a greyish white colour.

(3.) Before the blowpipe, this earth-like matter adheres to a hot platinum wire ring, swells out like the mineral Apophyllite, becomes perfectly white, and finally fuses to a clear transparent bead, which possesses double refraction in the polariscope.

(4.) It gives a reddish blue colour with cobalt oxide, P.P.,† and a very dark blue in H.P.

(5.) The hot bead sticks for some time, even to the aluminium tray underneath, when dropped. Shows that it retains heat.

(6.) The transparent bead becomes crystalline, opaque, and white, after treatment in H.P.; that is, after hydrogen from the hydrocarbonous pyrocone has been absorbed by it; it is again rendered transparent by a few seconds treatment in P.P.

(7.) Pyrochrome (coloured flame), brown-orange in O.P.; pale green-yellow in H.P.

(8.) In a long P.P., i.e., one inch from the tip of the blue, the bead becomes very fluid and drops off the wire (the reverse of every other known blowpipe flux); shows that it retains a large proportion of water?

(9.) A trace of CuO gives the bead a fine blue-green colour, even after H.P., with which it is impossible to produce the red opaque Cu₂O (proves a high oxidising power; retaining all its O., even in H.P.).

(10.) After slight H.P. on the transparent, pure bead, crystals, apparently in the hexagonal (rhombohedral) system, form over the surface as seen under a ¼ inch objective.

(a.) After long H.P. these crystals increase to such an extent that the bead becomes opaque, white, and shows a pink colouration on cooling (from the sulphur of the gas).

(b.) After powerful H.P. from a foot blower—which renders the bead nearly white-hot, and transparent on cooling—and then a gentle H.P. as above, which then caused superficial crystals only, quite a different kind of crystallisation is apparently induced in the interior of the bead, in the shape of large solid crystals, showing modifications between a hexagon and tetrahedron; the lower side, apparently, remaining hexagonal.

(11.) In re-heating this bead in O.P., it suddenly fell off the wire on to an agate slab, and immediately drew itself up from an oblate spheroid into an almost perfect sphere.

(To be continued.)

Industrial Richness of Raw Alunite in Powder.—P. Guyot.—The alunite of La Tolfa is not uniformly rich in alumina and potassium sulphate. Crystalline specimens may contain as much as 32 per cent of alumina, whilst in other portions the alumina may sink to 17.5. The part which is most easily pulverised is the richest in utilisable matter.—*Comptes Rendus*.

* I have just separated from the "mother-liquor," and dried on blotting-paper, some of these crystals, after standing for two years in a press. They seem flat, transparent, and shapeless like pieces of mica. They are evidently not in the least deliquescent.

† P.P. = peroxidising pyrocone; when the bead is held half an inch from the tip of the blue pyrocone, O.P. is at the point, H.P. inside the blue.

THE NEW ANALYSIS
OF THE BUXTON THERMAL WATER.

By J. C. THRESH, D.Sc.

THERE are many things in connection with the subject of mineral springs which modern science cannot be said to have satisfactorily explained or incontestably proved, and many others which formerly were enveloped in mystery, that have been found to admit of exceedingly simple explanations. The origin of the various mineral and gaseous constituents has always been a point of considerable interest, and has given rise at different times to a good deal of speculation. Many minds are so constituted that theorising and mental speculation have greater power of fascination, and are far more interesting to them than the process of probing nature by experiment to ascertain the truth. Imagination is as useful, and almost as necessary, to the man of science, as to the artist or poet, and the success with which he interrogates Dame Nature depends in a very great measure upon his ability to conceive methods by which he may directly or indirectly worm from her her treasured secrets; but it is always advisable, however, to make as certain as possible that our speculative structures are founded on facts, otherwise the most elaborately constructed fabric may suddenly tumble to the ground, and the reputation of the builder suffer in the general wreck. Thus the cause of the ascent of water in springs, the source of the heat, and of the constant temperature in thermal springs, are matters of considerable interest; but with regard to the famed waters of Buxton, that which has provoked most discussion, and most theorising, has been the attempt to explain in a satisfactory manner the origin or source of the immense amount of gas said to be contained in it, the constant temperature, and never-failing flow. Very little investigation is required to prove that the springs have been in existence from time immemorial, and that from the day on which the first thermometer was immersed in it until now, there has been no variation in its temperature—81.5° F. Observations taken as to the length of time required to fill the baths and reservoirs prove that in summer and winter, in dry weather and in continued wet, the flow is always the same. The nature of the gaseous and of most of the mineral constituents has been long ago ascertained with tolerable certainty; but that the gases should be present in such inexplicable quantities, as has been asserted by more than one chemist of repute, certainly required most positive confirmation. That some blunder had been committed seemed very probable, and the careful perusal of the only report at all entering into details, at once proved that such was the case; therefore, two winters ago, a series of experiments was instituted in order to arrive at the exact truth. But this investigation had not proceeded far before it was discovered that many things of importance in connection with the water had hitherto been entirely overlooked, consequently a complete and exhaustive examination of the whole subject was determined upon. The analytical results obtained, together with details of the analyses, were communicated to the Chemical Society, and a brief resumé of the whole will be given here in a more popular form, preceded, however, by a still more brief account of the results obtained by chemists who had previously examined the water, acknowledging our indebtedness for much of this information to Dr. Robertson's "Guide to Buxton and the Peak of Derbyshire."

Between the years 1733 and 1783 the thermal water appears to have been four times examined. The first analysis was made by Dr. Short, who found that each gallon contained 26 grains of solid matter, 13 grains being carbonate of lime, and the remainder "marine salt" and "nitre" in equal proportions. This very meagre and indefinite information was not increased by the two following investigators, but the fourth, Dr. Higgins, gave a much more satisfactory account of his labours. He found in the imperial gallon—

Sea salt (sodium chloride)	..	4.6 grains.
Calcareous earth, combined with acidulous gas (calcium carbonate)	15.1	"
Sulphate of calcium	.. ..	2.0 "
Chloride of magnesium	.. ..	1.6 "
Iron, combined with acidulous gas (carbonate of iron)	.. ..	0.6 "

Total 23.9

Although this is the first analysis worthy of the name, no mention is made of the gaseous constituents, but the defect was remedied two years later by Dr. Pearson, who published his results in a work entitled, "Observations and Experiments for Investigating the Chemical History of the Tepid Springs of Buxton." This book is chiefly remarkable for containing an account of the first attempt to examine and estimate the gaseous elements. He found each gallon to contain one-fourteenth of its volume of what he termed "permanent vapour." His examination of the saline matter was much more imperfect than that of Dr. Higgins, since he only detected three constituents, and overlooked others, the presence of which the latter gentleman had demonstrated. This defective work is the more singular since he gives an accurate account of the physical properties of the water, and otherwise proves himself to have been a painstaking and careful observer. He obtained less than 20 grains of solid matter from the gallon, and says that it consisted of—

Chloride of sodium	.. ..	2½ grains.
Sulphate of lime	.. ..	3½ "
Carbonate of lime	.. ..	14 "

Total 19½ "

The next analysis in chronological order is that made by Sir C. Scudamore and Mr. Garden in 1819, after an interval of thirty-five years, during which the science of chemistry had progressed with giant strides. The existence of a number of "permanent vapours" had been demonstrated, many new elements and compounds had been discovered, and the old method of analysis had been vastly improved upon. It is not surprising, therefore, that these chemists added much to our stock of knowledge. The gas dissolved in the water they found consisted of two permanent vapours, which they identified as nitrogen and carbonic acid gas, and these they determined as exactly as they were then able. They found in an imperial gallon—

Magnesium chloride	.. ..	0.773 grains.
Sodium	.. ..	3.200 "
Calcium sulphate	.. ..	0.800 "
" carbonate	.. ..	13.866 "
Extractive matter	.. ..	0.666 "
Loss	.. ..	0.693 "

19.998

Out of the 20 grains of saline matter they were only able satisfactorily to account for 18½, and in so far their work is defective; but their account of the result obtained by the actual analysis of the gaseous constituents is of more importance, as will afterwards appear. In the same volume of water they found—

Free carbonic acid gas	.. ..	2.00 cubic inches.
Nitrogen	.. ..	6.18 "

For thirty-three years the waters remain untroubled by the chemist; but at the expiration of that period Buxton had begun to flourish, all the sciences were advancing with unexampled rapidity, and it was thought advisable that one of the greatest chemists of the day should submit its waters to a searching examination, using large quantities of it for the purpose. A full account of the result of the analysis, executed in 1852 by Prof. Playfair at the School of Mines, London, at the request of the Duke of Devonshire's agent, will be found in the guide previously mentioned. The work bears every evidence of

most conscientious care, but is chiefly remarkable on account of a most singular mistake made by him in calculating the amount of nitrogen contained in the water. For the first time the gas evolved at the spring was quantitatively examined, proving it to be nearly pure nitrogen. One hundred volumes were found to contain, as mean of two experiments—

Carbonic acid gas	..	..	..	1'167
Nitrogen	..	..	..	98'833
and one gallon of water—				
Silica	..	..	..	0'666 grains.
Oxide of iron and alumina	..	..	..	0'240 "
Carbonate of lime	..	..	..	7'773 "
Sulphate of lime	..	..	..	2'323 "
Carbonate of magnesia	..	..	..	4'543 "
Chloride of magnesium	..	..	..	0'114 "
sodium	..	..	..	2'420 "
potassium	..	..	..	2'500 "
Fluoride of calcium	..	..	..	trace "
Phosphate of lime	..	..	..	" "

20'579 "

He does not tabulate in the same way the gaseous constituents, but states that he found 3'47 c. inches of carbonic acid gas, and assumes the volume of nitrogen in same quantity of water (one gallon), to be 206 inches.

Carbonic acid	..	..	..	3'47
Nitrogen	..	..	..	206

It will be noticed that whilst Pearson estimated the gaseous constituents at one-fourteenth the volume of the water, or about 19 cubic inches, Scudamore and Garden at 8½ cubic inches, three-fourths of which were nitrogen, Playfair assumes the presence of 209'47 cubic inches, of which 206 are nitrogen. The word *assumes* is written advisedly, for this analyst never attempted to estimate the nitrogen directly or by actual experiment, and never asserted positively that so much is present, but in an altogether erroneous manner calculates the quantity from his analysis of the evolved gas, and gives in his report as the reason "that there was no *very* accurate method for ascertaining the precise quantity of this gas in the water." The ground for this assumption shall also be given in his own words:—

"Judging from the analysis (*i.e.*, of the gas evolved at the spring) and the proportion of the gases, it is *assumed* that at the moment of issue, the water is charged with 206 cubic inches of nitrogen and 15'66 cubic inches of carbonic acid. This *assumption* is founded upon the proportional relation of the two gases. The proportion of carbonic acid in the water being determined, and the proportion of carbonic acid to that of nitrogen contained in the water being 1'2 to 98'8, the amount of nitrogen contained in the water at the moment of issue may *fairly be assumed* to be 206 cubic inches per gallon."

As before remarked, in no part of the report does he affirm that so much gas is dissolved in the water, and in asserting that "the proportion of carbonic acid to that of nitrogen contained in the water is as 1'2 to 98'8," he is really assuming the very thing he is trying to prove. For unless he could prove the presence of this amount of nitrogen, how could he logically assert that the two gases were present in the above ratio. Moreover, after all these assumptions, an error is made in a simple calculation, for $3'47 \times 98'8$

is 286, and not 206. This may, however, be a printer's error.

Unfortunately Dr. Playfair was entirely in the wrong when he took for granted that the gases existed in solution in the same proportion as in the free evolved gas, for he entirely overlooked the well known fact of the great difference in the solubility of the two gases. Carbonic acid gas dissolves under the normal pressure and temperature in about an equal volume of water, whilst nitrogen requires from 60 to 70 volumes for its solution. If, therefore, we take an excess of a mixture of these gases in any

proportion and treat it with water so as to cause absorption, it follows that the gas absorbed will be richer in the more soluble constituent than the portion remaining undissolved. Moreover, he must have been perfectly familiar with the law enunciated by Henry at the beginning of this century, and known as "Dalton's Law of Partial Pressures," from which it was possible to calculate from the composition of the evolved gas that of the gas dissolved. When the proportion and quantity of carbonic acid and nitrogen in the Buxton Thermal Water are calculated from the result of Playfair's analysis of the gas bubbling up at the spring, the results are very near the truth, as recently ascertained by direct experiment.

Whilst with truth remarking that the nitrogen could only be present in the water in solution and not in combination, and that there was not then known any "very accurate method of ascertaining the precise quantity of the gas," yet the utter impossibility of the water containing in solution any such quantity of gas, as he assumes, never for a moment suggests itself to his mind. Otherwise he would have ascertained by some sufficiently approximate manner of direct experiment whether such really could be the case. We feel that here we are in the presence of a psychological phenomenon, which we willingly leave to the students of that science to explain.

In 1860, Dr. Muspratt, of Liverpool, published the result of an analysis of the water, without giving any details, or even mentioning by what process he determined the gases. As he found less saline matter in the gallon than any chemist either before or since, and affirms the presence of nearly twice as much nitrogen as Playfair had assumed, we should not be justified in attaching any great degree of importance to his conclusions. Whilst Playfair appears to have been perfectly unconscious of the impossibility of his assumption being correct, Muspratt indirectly acknowledges the absurdity of his statement; for, in his "Dictionary of Chemistry," after giving as the result of his analysis, that one gallon of Thermal Water contained—

Carbonic acid	..	..	3'5 cubic inches
Nitrogen	..	..	504'0 "

He adds, "Dr. Robertson, in treating of the physical character of the Buxton waters, ascribes their brilliancy, when drawn, to the gas held in solution. Of course this must be fallacious, for very little gas is held in solution or dissolved." He first asserts that the water contains a large quantity of gas, then says very little gas is in solution. Finally, he proceeds to speculate on the origin of the nitrogen, and discusses what he terms "so unnatural a phenomenon." Strange to say, he never attempts to explain in what condition the gas did exist in the water, if not in solution; and, in contradiction to Playfair's statement, that "the nitrogen in the water could only be present in solution," he simply makes the affirmation that "very little gas is in solution." Truly an instructive example of scientific work and method, and of what he would probably call an "unnatural phenomenon." Possibly he may have regarded the whole thing as supernatural, and therefore incapable of proof or of substantiation by experiment; for without attempting such he proceeds to show how hypothesis after hypothesis *cannot even be conceived* capable of affording a scientific explanation of it. The exercise of much less ingenuity and very little trouble would have enabled him to come at the truth.

The result of the analysis of the saline constituents is subjoined. It differs somewhat considerably from Playfair's, but from the internal evidence alone, and we have nothing else in this case to judge from, there is no reason to assume that it was incorrect. (See next column).

In 1876 a London analyst, Mr. O. Hehner, who had been visiting here, and became interested in the waters, made an analysis of the residue left on evaporation, hoping, by aid of the recently discovered and exceedingly delicate method of spectrum analysis, to detect some constituents which possibly had been previously overlooked.

	Grains per gallon.
Carbonate of lime	8'541
" magnesia	3'741
" protoxide of iron	0'082
Sulphate of lime	0'330
Chloride of calcium	1'227
" magnesium	0'463
" sodium	2'405
" potassium	0'260
Silica	1'044
Nitric acid	trace
Organic matter	0'341
Fluoride of calcium	trace
Phosphate of lime	trace
	18'434

By this means he detected a trace of lithia: he also ascertained the presence of manganese, and affirmed that in small quantity he had found iodine. Playfair had carefully sought for this element, but failed to detect a trace; and in the course of the analysis, finally to be referred to, negative results were alone obtained in searching for it, although the saline residue from a large quantity of water was employed. As also will be shown in the sequel, a number of elements were overlooked which the spectro-scope is capable of detecting. Some correspondence followed the publication of the letter containing Mr. Hehner's results. A London physician, and a constant visitor to Buxton, contending that such an incomplete analysis, making no mention whatever of the gaseous constituents, was misleading, and ought never to have seen the light.

In the subjoined analysis, the results are expressed to the nearest third decimal place. In the original it is carried out to the fifth, giving it, as his critic remarked, "a sufficiently pretentious appearance."

Chloride of sodium	4'517
Sulphate of soda	0'202
" potash	0'660
" ammonia	0'016
" lime	0'674
Nitrate of lime	0'257
Carbonate of lime	9'186
" magnesia	4'727
" iron	0'037
" manganese	0'008
Silica	0'838
	21'131
Phosphoric acid	a trace
Iodine	"
Lithia	"

It will be noted that fluorine was not detected, and that nitrates are stated to be present. The correctness of this latter statement is doubtful; most certainly no such quantity was present when the water was last examined, nor when Playfair analysed it. The existence of such an amount of nitric acid in a deep well of water of such a character, and so organically pure, required confirmation.

The last analysis made of the Buxton thermal water occupied most of the writer's leisure during the winters of 1880-81 and 1881-82. Residing upon the spot, and with a laboratory within a very short distance, unusual facilities were enjoyed for making a prolonged and searching chemical investigation. The reason why the work was undertaken has already been given. The complete examination necessitated three series of analyses; the first, of the mud deposited near the mouth of the spring; the second, of the gas issuing from the spring, and of the gas dissolved in the water; and third, of the saline constituents.

Every thermal water deposits more or less rapidly upon cooling, or from loss of carbonic acid gas or exposure to the air, a mud or sinter, differing in appearance and in

composition according to the character of the strata through which the waters pass in their subterranean journeyings. Very frequently the examination of such deposits reveals the presence of elements which on account of their excessively slight solubility are present in the water in such minute quantities that their presence may be overlooked in an analysis of the water itself.

When the springs and reservoirs into which the water flows were examined, the slabs, walls, &c., were found to be coated with a very dark brown mud which stained the skin when rubbed between the fingers and thumb. It appeared of a peculiar character, and it was felt that its analysis could not but yield interesting results. Such proved to be the case. It was found to consist chiefly of the higher oxides of manganese in a hydrated condition, and capable of combining with oxygen when exposed to the air, or to water containing oxygen in solution. In composition it corresponds closely with that of many samples of psilomelane and wad, ores of manganese. The importance of the inference to be drawn from this discovery will be discussed later on. The following elements were in appreciable quantities, the first three being afterwards detected in the water:—Barium, strontium, lead, molybdenum, copper, cobalt, and zinc. Molybdenum has never before been discovered either in a mineral water or in a deposit from such a spring, but probably is derived from a molybdate of lead which may frequently be found in cavities of limestone rocks. The tabulated result of the analysis is appended.

Oxide of manganese	80'32
Sulphate of barium, sand, &c.,	1'08
Lead oxide	0'15
Copper	0'07
Molybdic acid	0'02
Cobalt oxide	0'30
Iron and aluminium oxides	1'36
Zinc oxide	0'46
Barium oxide	0'79
Calcium	5'31
Strontium	a trace
Magnesium	3'18
Carbon dioxide	3'23
Phosphoric acid	0'01
Water	3'93

100'21

The results obtained by the analysis of the gas evolved at the spring were in close accordance with those of Dr. Playfair, but it was noted that the composition of this gas varied slightly, according to the length of time during which it was allowed to remain in contact with the water under the reduced pressure to which it is subject when it has risen to the earth's surface. Thus the mean of two analyses of the gas collected at the mouth of the spring, and at once removed from contact with water, gave—

Nitrogen	99'12
Carbonic acid	0'88

whilst some of the gas which had been allowed to stand over a little water gave—

Nitrogen	98'63
Carbonic acid	1'37

This difference would be inexplicable were Dr. Playfair's assumption correct. Undoubtedly at some little depth the free gas consists of pure nitrogen, whilst at a still greater depth even that will be in solution.

In determining the amount and composition of the gas held in solution by the water at the moment of issue from the springs, the greatest care was taken to obtain reliable and accurate results, and as an appendix to the original paper an illustrated description will be found of the apparatus used in collecting and measuring the gases. The mean of a number of experiments gave the following results:—

	Cubic inches per gallon of water.
Nitrogen	6.1
Carbonic acid gas	4.1
Total	10.2

From this the calculated percentage composition is—

Nitrogen	59.78
Carbonic acid gas	40.22
	100.00

To dissolve 10.2 cubic inches of such a gaseous mixture at a temperature of 81.5° F. (that of the thermal water) would require a pressure of 1.64 atmospheres; consequently on exposing the freshly drawn water bubbles of free gas commence to make their appearance, and after a time the excess passes off, but this takes place, if the water is not agitated, much more slowly than might be anticipated, considering the insoluble character of the gas. In fact when the water is agitated as in bathing, the surplus gas is liberated almost instantaneously and in bubbles so minute that the water becomes opalescent. Doubtless much of the gas is liberated within the very pores of the skin during bathing, and acts in what may be considered its semi-nascent state, producing effects altogether unattainable by use of the same agent in any other condition.

The analysis of the mineral constituents was conducted after the manner of Baron Bunsen, in his examination of the mineral springs of Baden-Baden. The process, though exceedingly tedious, leaves nothing to be desired as regards the accuracy of the results, and has the advantage over older methods in allowing these results to be so completely checked that there is little danger of overlooking any of the constituents. As was previously stated the whole of the elements present in the deposit were not found in the residue obtained by evaporation of large quantities of the water, but this was doubtless owing to their almost entire insolubility, and to our ignorance of reactions sufficiently delicate to detect such minute quantities. Calculated into grains per gallon, the water was estimated to contain—

Bicarbonate of calcium	14.01
„ magnesium	6.02
„ iron	0.03
„ manganese	0.03
Sulphate of barium	0.05
„ calcium	0.26
„ potassium	0.62
„ sodium	0.84
Nitrate of sodium	0.03
Chloride of calcium	0.02
Chloride of sodium	3.10
„ ammonium	trace
„ magnesium	0.95
Silicic acid	0.95
Organic matter	0.02
Carbon dioxide	0.20
Nitrogen	0.19

27.32

Lithium, strontium, lead, and phosphoric acid traces.

From this analysis, or rather from the manner in which the results are expressed, it would appear as if the quantity of saline matter per gallon was much in excess of that found by any other observer; but this difference is only apparent, and arises from the fact that the compounds represented by them as carbonates are found here as bicarbonates. The carbonates of calcium, magnesium, iron, and manganese are practically insoluble in water, but in the presence of carbonic acid the bicarbonates are formed and these dissolve. Upon evaporating a water containing such salts, they are decomposed, the carbonic acid being given off and an insoluble carbonate remaining. This

decomposition is readily seen when a little of the Buxton Thermal Water is boiled in a glass flask. Hence, whilst the last analysis represents, as nearly as can be ascertained, the composition of the saline matter as it exists in the water, the former ones merely represent the result of the analysis of the water residue.

The further comparison of the various analyses, and of the Buxton Thermal Waters with those of other localities, must be reserved for a future paper, as must also the discussion of the inferences to be drawn from analysis, as to the origin of the gases, and the source of the constant heat, and of other subjects of a similar character admitting of the freer use of the speculative faculty.

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. XI.

Communicated by J. W. MALLETT,
Professor of General and Applied Chemistry in the University.

(Continued from p. 196.)

- (82.) *Analysis of Beautifully Crystallised Albite from the same locality (near Amelia C.H., Va.).* By R. N. MUSGRAVE, of Baykin's Depôt, Virginia.

This mineral occurs in fine large masses of beautifully clear, colourless, flattened crystals, delicately aggregated, so that the mass as a whole is easily shattered. Hardness = 6. Sp. gr. = 2.605. Analysis gave—

SiO ₂	68.44
Al ₂ O ₃	19.35
Na ₂ O	11.67
K ₂ O	0.43
	99.89

Corresponding very accurately with the tri-silicate formula—



- (83.) *Examination of a supposed Metallic Meteorite found in Augusta Co., Virginia.* By W. H. SEAMON.

The specimen in question, received from Mr. W. B. Alexander, of Waynesboro', Va., was a rough, pear-shaped mass of metallic iron, weighing about 1½ kilogrammes, covered with an oxidised crust of varying thickness, up to 13 millimetres. The iron was of pretty uniform gray colour, and fine granular fracture, and did not exhibit Widmanstätten figures on being treated with acid; it was spongy, and penetrated throughout by more or less oxide. Sp. gr. of the whole mass, including the crust, = 5.76. An analysis of as solid a portion of the interior of the mass as could be obtained gave—

Fe	90.45
Mn	0.10
C	0.19
S	0.15
P	0.37
SiO ₂	4.18
Al ₂ O ₃	0.49
CaO	2.16
O, and loss	1.91
	100.00

The silica did not appear to be gritty, and dissolved almost entirely on boiling with a solution of sodium carbonate. Nickel and cobalt were carefully tested for, but were not present.

It is pretty clear that this specimen, although looking

much like a meteorite. and found in the same county in which form masses (three of them large) of genuine meteoric iron have been found,* is of terrestrial and artificial origin—in all probability the remains of a mass produced in one of the early "bloomery" fires of this part of the country.

(84.) *On Metallic Iron accompanying Native Gold in Montgomery Co., Virginia.* By W. T. PAGE.

In examining some of the gold† obtained by alluvial washing in the bed of Brush Creek in the part of this State referred to, it was noticed that certain dark coloured grains were attracted by the magnet, and were malleable, and on sweeping with a magnet a considerable quantity of the "concentrated" sand from which this gold had come, and picking over with the aid of a lens the portion which had been attracted and removed, a good many such grains were secured, of various sizes, the largest weighing from 60 to 80 milligrams, while the smallest were almost dust; the average weight of those collected was about 5 m.grms. Some of the grains were rounded, but many appeared as flattened scales, often twisted as if taken off by a planing or lathe, and with rough ragged edges. They were but slightly oxidised on the surface. Sp. gr., taken on a very small quantity, = 7.20. Analysis gave—

Fe	97.12
Cu	0.04
S	1.47
Quartz	0.82
	99.45

The absence of carbon, phosphorus, nickel, cobalt, tin, and manganese was proved.

Investigation at the locality from which the gold came showed that no tools were used at the washings except picks and shovels, and that no mechanical work of any kind is now, or has ever been, done at a higher level in the valley of Brush Creek which might have led to the distribution of particles of iron. The grains of iron obtained, both from their shapes and the size of some of them, were quite unlike what one might expect to find detached from such tools as picks and shovels in their ordinary use. The probability seems very strong that we have here a case of the occurrence of terrestrial native iron, and from the amount found in the small parcels of gold and auriferous sand examined, these grains must be pretty extensively distributed, and must exist in the aggregate in considerable quantity. Such occurrence of native iron along with gold has been previously reported. Thus Molnar mentions it as found in the auriferous sand of Ohlapien, in Transylvania,‡ and Genth has examined fragments of it, the largest of which was half an inch long, occurring in (on?) the bed rock of the gold placers of Camp Creek, Montana, under six feet of gravel, and associated with native lead.§

(85.) *Examination of similar Grains of Metallic Iron accompanying Native Gold in Burke Co., North Carolina.* By W. T. PAGE.

The detection of native iron under the circumstances just described led to an examination for it of a parcel of auriferous sand ("concentrates") from Burke Co., N. Carolina, the bulk of the sand consisting of zircon, monazite, magnetite, &c. Malleable metallic grains were found, quite like those from the Virginia sand, many of them irregular, twisted, and ragged, weighing from 113 m.grms. down to 0.2 m.grm.; average weight about 7 m.grm. Sp. gr. = 7.57. Analysis gave nothing but—

Fe	99.77
Co	trace
Sn	trace (?)
Quartz	0.25

100.02

The presence of a trace of cobalt, though in too small quantity to be weighed, was well ascertained. As regards the tin the evidence is merely that a brown colouration was given by sulphuretted hydrogen in the solution of the iron, and the absence of copper was established. If it be admitted that these fragments of iron did not come from the tools used by the gold washers, as seems to be almost certain, it is interesting to find such evidence of wide distribution of native iron as is afforded by this examination of specimens from another state, though derived from the same general geological region.

(86.) *Analysis of Fergusonite from Brindletown, Burke Co., North Carolina.* By W. H. SEAMON.

The mineral, sent me by Mr. W. E. Hidden, who first observed it at this locality, was in small crystals and crystal fragments, of distinctly tetragonal habit, reddish brown in colour, with pale yellowish brown streak. Translucent in thin splinters. Lustre between vitreous and resinous. Brittle. Fracture conchoidal. Hardness = 6. Sp. gr. = 5.6. Analysis gave—

Nb ₂ O ₅	43.78
Ta ₂ O ₅	4.08
WO ₃	0.76
SnO ₂	5.81
UO ₂	37.21
Y ₂ O ₃ , &c.	0.66
Ce ₂ O ₃	3.49
Di ₂ O ₃	1.81
La ₂ O ₃	0.63
FeO	1.62
CaO	
H ₂ O	
	99.87

As it has been stated by Smith† that this mineral is "totally free from tantalic acid," care was taken in proving the presence of tantalum. A metal or metals of the yttrium group, but of higher atomic weight (erbium, ytterbium, &c.), occurs with the yttrium, but in small proportion only. Counting the water as basic, the above figures lead to the ortho-niobate formula of Fergusonite—



as nearly as can be expected in view of the uncertainty of several of the atomic weights concerned, especially those of the yttrium metals.

(87.) *Analysis of a Niobate, which has been improperly called Euxenite, from the Wisemann Mica Mine, Mitchell Co., North Carolina.* By W. H. SEAMON.

This mineral, of which the specimens examined were also received from Mr. Hidden, although I had previously obtained it from another source, was described some years ago by J. L. Smith‡ as euxenite, though neither in physical characters nor in chemical composition does it agree with the mineral of that name from Norway, of which I have long had specimens.

The material examined by Mr. Seamon was compact, reddish brown in colour, with lustre between resinous and adamantine, and pale yellowish brown streak. Hardness = 5.5. Sp. gr. = 4.33. There was a yellowish crust over the outside of the fragments. The purest por-

* Described by J. W. Mallet in *Amer. Journ. of Science*, July, 1871, and May, 1874.

† Described and analysed last year by Mr. S. Porcher, then a student in this laboratory.—*CHEMICAL NEWS*, vol. xiv., p. 189.

‡ *Watts's Dictionary of Chemistry*, iii., 336.

§ *Amer. Phil. Soc.: Philadelphia*, xl. (1873), 443.

* Weighed together. The sp. gr. of the mixed oxides was very carefully taken, and from this the relative quantities of niobium and tantalum were calculated.

† *Jahrb. für Mineralogie*, 1881, 2. Mem. 337; quoted in *Journ. Chem. Soc.*, Feb., 1882, 151.

‡ *Amer. Journ. of Science*, May, 1877, 365.

tions, free from this crust and from adhering scales of mica, were picked out, and gave on analysis—

Nb ₂ O ₅	.. .. .	47.09
WO ₃	.. .. .	0.40
SnO ₂	.. .. .	
UO ₂	.. .. .	15.15
Y ₂ O ₃	.. .. .	13.46
Ce ₂ O ₃	.. .. .	1.40
Di ₂ O ₃	.. .. .	
La ₂ O ₃	.. .. .	4.00
FeO	.. .. .	7.09
CaO	.. .. .	1.53
H ₂ O	.. .. .	9.55

99.67

The specific gravity of the Nb₂O₅ after ignition proved it to contain no Ta₂O₅, or but a trace. Spectroscopic examination showed that the Y₂O₃ contained but little of any oxide of the Eb or Yb class. Di was present in larger proportion than La, but the two were not separated.

These results indicate an ortho-niobate of the general formula—



in which about one-eighth of the hydrogen of the water is basic, the actual distribution of the basic elements being nearly—



Euxenite, beside containing a large proportion (up to 16 per cent) of titanate oxide, which is altogether wanting in this mineral, is a *meta*-niobate, as shown by Rammelsberg.* The large proportion of water, most of which cannot be brought into the formula as basic, and the general appearance of the mineral, with its external crust of yellowish material which penetrates the interior in some places, as well as the rather low specific gravity, makes it probable that we have here a product of alteration of Samarskite (with which it is found) or some allied species.

(To be continued.)

NOTICES OF BOOKS.

Chemiker-Kalender, 1883. *Beilage zum Chemiker-Kalender*, 1883. By Dr. RUD. BIEDERMANN. Berlin: Julius Springer.

THIS little work, in two volumes, intended as a pocket reference-book for chemists, physicists, mineralogists, &c., has its English and French representatives in the well-known "Chemist's Pocket-Book" and "Agenda du Chimiste." Like these, it consists of a large number of Tables and data of every description, wholly indispensable to the chemist.

The value of such a work as this to the scientific man depends greatly upon the facility with which any required data can be found when wanted, and the reliance that can be placed on their accuracy, few busy chemists having opportunities to consult the original memoirs, or time at their disposal to search through standard works of reference; consequently it becomes a most important consideration for them that what they possess should be accurate.

The methodical arrangement of the contents of this work before us and the variety of the information leave little to be desired as regards the first requisite: the care with which the present edition has been revised is a sufficient guarantee for its accuracy.

The first volume, which is essentially chemical, gives over sixty pages to a diary, in which, instead of each day being labelled with the name of a Saint, a Feast, or a Fast, we have the birth register of many of the most emi-

nent chemists, dead and living. The calculations required in gas measurements, analyses, and such like, are those of every-day use in the laboratory, logarithms being freely introduced whenever the work can thereby be shortened. The Tables of specific gravities and percentage content of the more common solutions are drawn up under Alkalies, Acids, and Salts, followed by a list of miscellaneous solutions, as Sugar, Alcohol, Albumen, &c. Under Solubilities are given a series of useful Tables, as Gases in Water and in Alcohol, Solids in Water and in Spirits of Wine, Sugar in Water, and Sugar in Alcohol, each of importance in one or other of the large chemical industries.

The remainder of the volume is taken up with long lists of organic and inorganic compounds, their formulæ, melting- and boiling-points, and solubility in various menstrua; Tables for qualitative analysis, spectral analysis, and gas analysis, assaying in the wet and dry way. The last table, valuable to the mineralogist, comprises over 500 minerals arranged alphabetically, with their formulæ, specific gravity, hardness, crystalline form, and colour. To the analyst this Table might be of more use if the minerals were classified in some way, such as the silicates in order of the principal base, ores of copper, iron, &c.

The Supplement to the *Kalender* contains 89 Tables relating to physical subjects, collected under the headings Mathematics, Weights and Measures, Heat, Tension of Vapours, Light, and Electricity; followed by short descriptions of the various methods for determining the densities of solids, liquids, and gases. In an Appendix are given the principal scientific educational institutions in Germany, the professors, and the subjects taught.

The utility of such a book as the present is beyond question; the fact, however, of it being in two separate parts may not render it quite so handy a *vade-mecum* as it might otherwise be if it were in one.

Address in Surgery. By W. STOKES, F.R.C.S.I., President of the Pathological Society of Ireland, &c. London: J. and A. Churchill.

THE Address before us, delivered at the late Jubilee Meeting of the British Medical Association, bears for its motto the very apposite sentiment "Vérité dans la science, moralité dans l'art." The speaker expounds his aspirations for the future career of the distinguished body whom he was addressing. This Association, as he not unjustly maintains, has been "faithful in its efforts to raise the social status of the profession—faithful in its attempts to extricate public opinion from the quagmires of sentimentalism and folly." Among the tasks remaining to be accomplished, Mr. Stokes urges the importance of a higher general and scientific culture for candidates for the medical profession. The word "general" is here open to more than one interpretation, and it is hence impossible for us to decide how far our sympathies would accompany the learned speaker.

We have next a summary of the chief advances which have been effected in the art of medicine during the last half century. The antiseptic treatment of wounds, especially, is discussed at length. The author, after a careful survey of the results of what is known as "Listerism," gives his verdict in its favour.

Lastly, we have a notice of the "Association for the Advancement of Medicine by Research." The task of this Association, as the author holds, is not easy. It "will have to deal with a section of the public who refuse to be instructed; refuse to recognise established facts; refuse to weigh evidence; substitute groundless assertion for argument, and wilfully and deliberately accuse the scientific physiologist of selfishness and cruelty. In creating so unjust a prejudice there is, I fear, a wilful attempt to pervert the moral sense of the public." He asks, Are efforts for the advancement of physiology "to be thwarted and hindered in the country of Harvey and Jenner?" Truly "a question to be asked."

* *Journ. Chem. Soc.* [2], ix., 196.

Tokio Daigaku (University of Tokio). The Calendar of the Departments of Law, Science, and Literature. Published by the University, 2540 (1880).

TURNING to the Faculty of Science we find a very numerous staff of professors and assistants, of whom all but seven are native Japanese. There are in chemistry a professor, an assistant professor, two assistants, and a lecturer, besides a professor and an assistant in assaying. In the department of Science there are, it appears, six distinct curricula, viz., chemistry, mathematics with physics and astronomy, biology, engineering, geology, mining and metallurgy. These six courses are all identical for the first year, but for the three subsequent years each student is required to elect one of the courses, and pursue as his special studies those of the course chosen. It is further to be noted that beyond a knowledge of the three great languages of the modern world—English, French, and German—the science student is not compelled to occupy his time with literature. A graduating thesis is in all cases one of the tasks required in the last year of the course. It seems to us, as far as can be judged from the survey before us, that it is the object of the University to initiate the students as early as possible into original scientific work.

CORRESPONDENCE.

ELECTRICITY AND COMETS.

To the Editor of the Chemical News.

SIR,—I am not aware whether the part which electricity may possibly play in some of the phenomena exhibited by comets has been considered by physicists with any special attention; but may it not be a not unimportant auxiliary agent in some of the phenomena they display; why should not electric currents circulating around the sun, like those which circulate about our earth, act inductively upon the mass of the comet which is so rapidly approaching them, producing currents in an opposite direction to themselves, according to the well known laws of induction of currents; and seeing that the mass of the comet is not continuous, there would appear incessantly between the meteoric fragments, electrical discharges, which would, in passing through the gaseous envelope, develop the high temperature spectra of its component gases; whereas such is, I believe, the nature of the spectra actually observed. At the same time these incessant discharges might have something to do with the light emitted by comets.

Another effect might also be not unconnected with these currents. I allude to the apparent solar repulsion of the less dense matter, which, arising in a wave-like motion from the nucleus, has appeared to pass off towards the tail; for it is clear that any currents which might be produced must be such as to cause a repulsion between the sun and the comet.—I am, &c.,

LESTER REED.

Hyrst-hof, South Park Hill Road,
Croydon.

A WARNING.

To the Editor of the Chemical News.

SIR,—I am indebted to the "warning" of your correspondent, Mr. A. Proudlock, of October 20, for being enabled successfully to parry an attempt to extract money by a man who is evidently the person referred to in his letter. His last name is Luis, but having taken the precaution to make enquiries of Dr. Campbell Brown, whom he professed to know, I find that he has been carrying on similar operations in Liverpool under the name of Weiss.—I am, &c.,

WILLIAM A. TILDEN.

The Mason Science College,
Birmingham, 30th October, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 15, October 9, 1882.

Objections of a Mechanical Order to the Present Theory of Electricity.—A. Ledieu.—The author in seeking for a connection between the theory of electric machines and that of heat engines, has met with inextricable difficulties, resulting from the current principles of electrical science. According to the opinion of most physicists this science presents to the mind not a few confused ideas. These the author expounds mathematically.

Transmission of Work to a Great Distance by Means of an Ordinary Telegraphic Line.—M. Deprez.—In the author's first experiment he obtained at Munich a work of 38 kilogrammetres per second ($=\frac{1}{4}$ horse-power) with a speed of 1500 revolutions per minute. The generating machine, placed at Miesbach, revolved at the rate of 2200 turns per minute. The two machines being identical the proportion of work recovered at Munich, to that expended at Miesbach, was 60 per cent.

Thermoscopic Method for the Determination of the Ohm.—G. Lippmann.—The author's method differs from that of Mr. Joule merely by not requiring the measurement of quantities of heat, nor a knowledge of the mechanical equivalent of the heat E. This latter point is not unimportant, since, in Mr. Joule's calorimetric method, the final approximation is limited by the uncertainty which exists as to the exact value of the number E, so that the possible error is close upon 1-100th.

Rotatory Polarisation of Quartz.—J. L. Soret and E. Sarasin.—Not capable of useful abstraction.

Experiments made to Determine the Compressibility of Nitrogen Gas.—E. H. Amagat.—The author expresses his results graphically. His method and his apparatus are different from those of M. Cailletet.

Certain Compounds of Tin Bisulphide and Bismuthide.—A. Ditte.—The author describes the potassium sodium, ammonium, barium, strontium, and calcium sulpho-stannates, potassium and ammonium selenio-sulpho-stannates, and potassium selenio-stannate.

Fermentation of Nitrates.—M. M. Gayon and Dupetit.—The authors, referring to the researches of M. M. Schloesing and Müntz, which establish the fact that nitrification in the soil and in organic liquids is due to the development of aerobic microbia, demonstrate that the inverse process, the reduction of the nitrates, is also a physiological phenomenon due to the action of anaerobic organisms.

Transformation of Amides into Amines.—M. Baubigny.—It is known that on heating a primary or secondary amine with a compound ether, there is produced an amide, and the alcohol of the compound ether is set at liberty. These amides differ from the corresponding salt of the corresponding amine by four volumes of watery vapour which are eliminated. Inversely these amides can fix 4 vols. of watery vapour, thus regenerating the primitive salt. The same amides are also capable of fixing 4 vols. of the vapour of alcohol, in which case the salt regenerated is the primitive salt in which the amide is replaced by a substituted amine, a derivative of the alcohol employed.

Decomposition of Tertiary Amyle Acetate by Heat.—N. Menshutkin.—On studying the etherification of the tertiary alcohols and acetic acid, the author has found that it does not proceed regularly; the quantity of ether formed is minimal, and there are produced ethylenic.

hydrocarbides. He connects the formation of these compounds to the dissociation of the acetic ethers of the tertiary alcohols at the temperature of the experiment.

No. 16, October 16, 1882.

National Conception of the Nature and the Propagation of Electricity, deduced, first, from the Consideration of the Potential Energy of the Etherial Matter Associated with Ponderable Matter; Second, from the Mode of Production and Transmission of Work, derived from the Variations of this Energy.—A. Leduc.—A mathematical paper not capable of useful abridgment.

Indices of Ordinary and Extraordinary Refraction of Iceland Spar for Rays of Different Wave-lengths up to the Extreme Ultra-Violet.—E. Sarasin.—The author's results are given in the form of tables.

M. Helmholtz's Theory of Double Electrical Strata. Calculation of the Magnitude of a Molecular Interval.—G. Lippmann.—Not capable of useful abstraction.

Electrolysis of Hydrochloric Acid.—D. Tommasi.—With concentrated acid acted upon by two Daniell elements, the platinum positive electrode is slightly attacked, hydrogen is evolved at the negative pole, and at the positive oxides of chlorine. If the acid is dilute the platinum is not attacked, but the gases given off are the same. The presence of hypochlorous acid is probable, but not that of hypochlorous acid, which, if formed, would, in contact with hydrochloric acid, be at once resolved into water and chlorine.

Reduction of Nitrates in Arable Soils.—MM. Dehérain and Maquenne.—Nitrates may exist in an ordinary arable soil if air is excluded without giving off nitrogen. This gas only appears when the proportion of organic matter is augmented. Under certain conditions nitrogen monoxide is also evolved. The reduction of nitrates only occurs when the atmosphere of the soil is absolutely free from oxygen.

Chronic Antimonial Poisoning.—MM. Caillol de Poncy and C. Livon.—The results are very similar to those of slow arsenical poisoning. Fatty degeneration of the liver and the lungs was strongly marked.

Journal für Praktische Chemie.

New Series. Vol. xxvi, Nos. 12, 13, and 14.

Researches on Physiological Oxidation.—M. Nencki and N. Sieber.—The authors, continuing their researches on the "Decomposition of Grape-Sugar and Uric Acid by Alkalies at the Temperature of Incubation," proceed to examine what part, if any, is played by atmospheric oxygen in the decomposition of various organic compounds when they are digested in alkaline solutions at the same temperature. The substances examined are chiefly such as are constituents of aliments or of the animal body itself. In following up the results obtained with grape-sugar, they communicate observations on the etiology of *diabetes mellitus*. They conclude that the transformation of the alimentary matters into acids, after which they are converted by the alkaline carbonate of the blood and the tissues into neutral salts, is an essential condition for their combustion in the plasma of the tissues. It seems probable that the cause of *diabetes mellitus* lies in the inability of the organism to convert grape-sugar into lactic acid or other acids, e.g., glykuronic acid. Schultzen reached the same conclusion by another way.

The History of the Basic Products of Putrefaction.—M. Nencki.—The author, referring to a memoir in the *Comptes Rendus* (xciv., 1601) by A. Gautier and A. Etard, states that the second alkaloid described by them, $C_8H_{13}N$, was obtained and analysed by himself six years ago.

On Resocyanine, and the Action of Acetacetic Ether upon the Phenols in the Presence of Dehydrating Agents.—Max Wittenberg.—Does not admit of useful abstraction.

Condensation-products of Phenols and Acetic Acid, and a Simple Method of obtaining the Acid Ethers of the Phenols.—Faustin Rasinski.—The author describes phenaceteine, orcaceteine, and orcacetophenon, phenol-benzoic ether, resorcine-dibenzoic ether, and orcine-benzoic ether.

The Preparation of Grape-sugar according to Neubauer's Direction by means of Schwarz's Method, and its Purity.—Prof. Worm Müller.—The author shows, in opposition to Soxhlet, that pure grape-sugar can be obtained by this method.

The Preparation of Grape-sugar, and its Titration with Knapp's Solution.—J. C. Otto.—A continuation of the last paper. The author compares the grape-sugar obtained by the process in question with a sample of admitted purity, and finds them equally good.

Instructions for the Determination of the Isomerism of Alcohols and Acids by means of Data drawn from their Etherification.—M. Menshutkin.—The new method for determining the isomerism of the alcohols consists in etherifying the alcohol under examination with a molecular quantity of acetic acid at 155°, and determining both the speed and the limit of etherification. The author gives certain necessary precautions, tables for comparison, and the characteristics of the primary alcohols, the primary iso-alcohols, the non-saturated primary, the secondary and tertiary alcohols, and phenols. In order to determine the isomerism of acids they are brought into reaction with a molecular quantity of isobutylic alcohol at 155°, and the observed speed and limit of etherification are compared with those laid down in the appended tables.

Nitrate of Tin.—Rudolph Weber.—The author has observed the formation of an easily inflammable tin nitrate when alkaline nitrates, or moist mixture for gun-powder, come in contact with tin solder. He recommends that such solder should be avoided in powder-mills.

An Explanation.—H. Kolbe.—The author points out that A. Klepl's note on an unstable compound of phenol and carbonic acid (vol. xxv., 464) had been, without the knowledge of the author, anticipated by Prof. L. Barth.

Biedermann's Central-Blatt für Agrikultur-Chemie, Vol. xi., Part 8.

The Injurious Constituents of the Smoke of Copper, Lead, and Zinc Smelting-Works, and their Removal.—Prof. M. Freytag.—The injury occasioned to vegetation in the neighbourhood of smelting-works, or establishments where large quantities of coal rich in sulphur are consumed, was examined thirty-eight years ago by Stöckhard, and referred to the poisoning of the soil by the sulphurous acid emitted and the metallic substances (especially lead oxide) mechanically volatilised. The author having re-examined the question concludes that the injurious action of furnace-fumes is due not to sulphurous acid and metallic oxides, but to sulphuric acid and soluble sulphates. Sulphurous acid is hurtful only when it is absorbed by moist leaves, and is rapidly oxidised to sulphuric acid. A direct poisoning or deterioration of the soil by acid vapours and accompanying metallic compounds does not occur. The latter, however, may become dangerous when they are deposited on the leaves of plants, and thus introduced into the bodies of cattle. Moist winds (the west wind) increase the zone of injury around smelting-works, which, in consequence, has its greatest extension eastwards. The gases are most injurious when they pass over plants moist with the evening and morning dews. Such gases have a peculiar disposition to follow a river without regard to its direction. To prevent a mistaken diagnosis the author points out that a number of

animal and vegetable parasites, as well as frost, drought, and a bad condition of the soil, may occasion phenomena very similar to smoke-damage. Flue-dust is arrested by passing the fumes through condensation-fumes. It contains more than 50 per cent of anhydrous sulphates and 7½ per cent of arsenious acid. The acid fumes are due not merely to the sulphur of the ores which escapes oxidation in the lead chambers, but to the sulphur present in coal. The author proposes to pass the gases, first freed from flue-dust, through a lead chamber in which they encounter a shower of "atomised" sulphuric acid.

Quantity and Composition of the Rain and Drainage Water at Rothamsted.—Messrs. Lawes, Gilbert, and Warington.—From the *Journ. Roy. Agr. Soc. of England*.

Manurial Experiments on Sugar Beets in Süderdithmarschen.—Vitter Thiessen.—Comparative experiments with soda, saltpetre, and Mejillones guano. The former of these manures greatly increased the crop without perceptibly injuring the quality.

Manurial Experiments with Soluble and Finely-ground Phosphates at Crawley-Mill Farm, Woburn.—Dr. A. Voelcker.—From the *Journ. Roy. Agr. Soc.*

The Analytical Determination of Reverted Phosphates.—MM. Fresenius, Joulie, Millot, Petermann, &c.—The compiler describes the ammonium citrate method as devised by Fresenius, and modified by Joulie, Petermann, &c., and points out the disturbing effects of gypsum, calcium chloride, chalk, and ammonium carbonate.

Examination of Sheep's Milk under Different Conditions of Nutrition.—Prof. Weiske and Dr. Keunepohl.—The milk of the sheep is distinguished from that of the cow by a higher percentage of solids, albumenoids, and fat.

Theoretical Considerations on the Problem of Assimilation.—J. Reinke.—Not suitable for useful abstraction.

Occurrence of Allantoine and Asparagine in the Young Leaves of Trees.—E. Schulze and J. Barbieri.—From the *Journ. für Prakt. Chemie*.

The Reducing Properties of Living Cells.—J. Reinke.—From the *Ber. der Deutsch. Chem. Gesells.*, as is also the following paper:—

Reducing Properties of Living Protoplasm.—O. Loew and T. Bokorny.

A Contribution to the Knowledge of the Easily Oxidisable Compounds of the Vegetable Body.—J. Reinke.—The author's researches show that readily oxidisable principles occur in plants of very different families, belonging apparently to the atomatic series. It may be suspected that they are connected with the respiratory functions.

Need for Water among different kinds of Grain.—Dr. Paul Sorauer.—Not adapted for useful abstraction.

New Method of Testing the Germinating Power of Seeds.—L. Digeon.—The author takes a given number of seeds, lays them one by one carefully upon burning charcoal kept at a glow, and observes how they burn. Good seeds spring up, turn over, and burn with a crackling noise, which is stronger the larger the seeds, whilst seeds of inferior germinating power smoulder slowly, with a faint emission of smoke.

Constituents of the most important Articles of Diet for Invalids and Children, and of certain Proprietary Foods.—Dr. Stutzer.—In some foods for children the digestible albumenoids are to the carbohydrates only as 1:40, 1:12, 1:20, &c., whilst in human milk the proportion is 1:5. The worthlessness of the foods in question is at once evident.

Proportion of Sulphuric Acid in Red Wines, and on De-acidifying Wines with Potassa or Lime.—Prof. J. Nessler.—The author has determined the amount of sulphuric acid in a series of wines of different vintages

and grown on different soils. A normal wine, neither contaminated with gypsum nor sulphured, never contains more than 1·3 grms. potassium sulphate per litre.

On Phylloxera Vastatrix.—A compilation of suggested remedies for this plague.

Moniteur Scientifique, Quesneville.
August, 1882.

Study on the Formation and Constitution of β -Naphtho-quinone and on some of its Derivatives.—C. Liebermann and P. Jacobson.—The results of the authors' investigations are that β -naphtho-quinone is an isomer of α -naphtho-quinone, the two atoms of oxygen being contained in the same nucleus and occupying adjacent positions. On introducing the group NO_2 into aceto- β -naphthalide, or the groups NO and N_2 into β -naphthol, we substitute the same atom of hydrogen which occupies the ortho-position; in the case of α -naphthol the action of the group N_2 occurs in the para-position. The anilides and toluides of β -naphtho-quinone have an acid character; the isomeric derivatives of α -naphtho-quinone still contain the original quinonic group and are insoluble in alkalis. The transformation of the anilide of β -naphtho-quinone into isomeric α -derivatives is the result of two very distinct reactions.

α - and β -Amylane in Cereals.—C. O'Sullivan.—From the *Journ. of the Chem. Soc.*

Tolerance of "Plastered" Wines.—M. Mencki.—From the *Journ. für Praktische Chemie*.

The Ptomaines and their Importance in Toxicological Chemistry and in Judicial Researches.—M. Huseman.—From the *American Journal of Pharmacy*.

MEETINGS FOR THE WEEK.

MONDAY, 6th.—Royal Institution, 5. General Monthly Meeting. Society of Chemical Industry, 8. "The Flashing Test for Petroleum," Prof. Abel. "New Process for the Manufacture of Sodium Sulphide and Potassium Sulphide," W. Weldon, F.R.S.
SATURDAY, 11th.—Physical, 3. "Three Historical Notes on Physics," Prof. S. P. Thompson. "Conservation of Energy and the Theory of Central Forces," W. K. Browne.

TO CORRESPONDENTS.

Thomas Weir.—Richardson and Watts's "Technology," published by Baillière.

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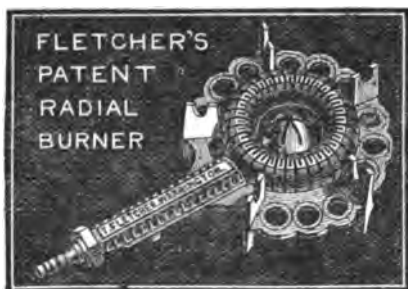
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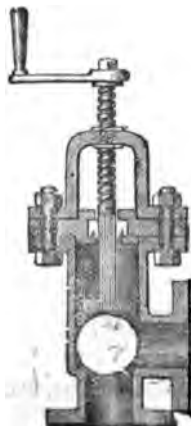
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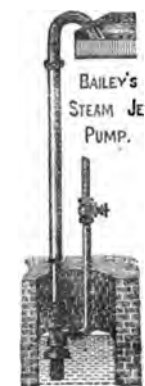
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THE CHEMICAL NEWS.

VOL. XLVI. No. 1198.

SEPARATION OF GALLIUM.

By M. LECOQ DE BOISBAUDRAN.

Separation from Tin (Stannic Salts).—1. The best process is to treat a decidedly acid hydrochloric solution with a prolonged current of hydrosulphuric acid. The tin sulphide does not retain gallium. The operation succeeds equally well with the stannic, the metastannic, or the stannous chloride. In the last case brown stannous sulphide is formed.

2. The solution in sodium or ammonium sulphide is treated with an excess of hydrochloric acid. The tin sulphide retains little or no gallium; it may be re-dissolved in ammonium hydrosulphate and re-precipitated with hydrochloric acid.

With the stannous salts we use an alkaline sulphide saturated with sulphur, which converts the stannous sulphide into the corresponding stannic compound.

3. The salts of manganese, if added to the solution of the gallio-stannic compound in an alkaline sulphide form manganese sulphide, which carries down gallium. Unfortunately there is great difficulty in collecting the manganese sulphide completely, and in washing it well. In general a certain quantity of stannic sulphide remains upon the filter after the manganese sulphide has been treated with hydrochloric acid. This stannic sulphide should be re-dissolved in ammonium hydrosulphate and the solution treated either with a salt of manganese or dilute hydrochloric acid. Notwithstanding these inconveniences the present process is sometimes applicable to the extraction of traces of gallium contained in large masses of sulpho-alkaline tin compounds.

It may be useful to give certain cautions to chemists about to analyse galliferous compounds.

A.—Stannic chloride is not immediately precipitated by potassium ferrocyanide in a very acid hydrochloric solution. By degrees a slight opalescence appears, and if the solution is not very dilute the whole finally forms a solid jelly without the separation of any precipitate. It is a singular thing that if the liquid contains gallium chloride even in a very sensible proportion, there is formed no precipitate of gallium ferrocyanide during the long period for which the mixture remains limpid, whilst a check-sample containing an equal weight of gallium chloride, but without stannic chloride, gives a copious precipitate. If heated, very acid stannic chloride becomes turbid as soon as potassium ferrocyanide is added. Hence it is necessary to remove tin before determining gallium by means of ferrocyanide.

B.—Tin and gallium cannot be separated by treating their alloy with nitric acid. Metastannic acid retains notable quantities of gallium even after prolonged washings.

C.—It is difficult to separate gallium and tin by reducing the latter metal with zinc. In a very acid solution the tin is not entirely deposited, and if the liquid is nearly neutral a quantity of gallium is rendered insoluble.

D.—Stannic oxide precipitated at a boil with sulphuric acid carries down much gallium.

Separation from Antimony (Antimonious Salts). 1. The most simple method is to treat the hydrochloric solution with sulphuretted hydrogen. If the acidity is suitable no antimony remains in solution, and we obtain Sb_2S_3 free from gallium. The separation is effected even if the acid solution has been rendered previously turbid by dilution. If the liquid is too acid, and if a little antimony has thus escaped the action of the sulphuretted

hydrogen, we add a few drops of ammonia (but without neutralising the solution), and thus collect a small supplementary precipitate of sulphide. Sulphuretted hydrogen also separates gallium from antimonious salts, e.g., the hydrochloric solution of potassium bimeta-antimoniate and potassium bi-antimoniate suspended in water acidified with hydrochloric acid.

2. The solution in ammonium hydrosulphate is treated with an excess of dilute hydrochloric acid. If it is feared that traces of gallium have been left in the antimony sulphide it is re-dissolved in an alkaline sulphide and re-precipitated with hydrochloric acid.

This process applies to the antimonious as well as to the antimonious salts.

3. Potassium ferrocyanide precipitates gallium from a very acid hydrochloric liquid containing antimonious chloride. Distinct traces of antimony are found in the deposit. It is therefore re-dissolved in potassa and re-precipitated by means of hydrochloric acid to which a few drops of ferrocyanide have been added.

4. A salt of manganese, added to a solution in ammonium hydrosulphate, removes slight traces of gallium mixed with much antimony. This process, useful in certain special cases, presents the drawbacks pointed out above, when speaking of the separation of tin and gallium by means of manganese sulphide. It is equally applicable to antimony in all states.

Zinc reduces the salts of antimony much more completely than those of tin, but this reaction is not well applicable in analysis because, according to the degree of acidity, either antimony escapes reduction or a little gallium is carried down. There is also loss in consequence of the formation of antimony hydride.—*Comptes Rendus*, No. 17, xcv.

NEW METHOD OF DETECTING DYES ON YARNS AND TISSUES.

By JULES JOFFRE.

The reagents employed are—a solution of caustic potassa in 10 parts of water; hydrochloric acid diluted with an equal bulk of water, or occasionally concentrated; nitric acid, ammonia, ferric sulphate, and a concentrated solution of tin crystals. The most convenient method of operating is to steep small portions of the cloth under examination in a little of the reagent placed at the bottom of a porcelain capsule. The bits are then laid on the edge of the capsule, when the changes of colour which they have undergone may be conveniently observed. It is useful to submit to the same reagents simultaneously portions of cloth dyed in a known manner with the wares which are suspected of having been used in dyeing the goods under examination.

Red Colours.

By the action of caustic potassa the reds are divided into four groups: 1, those which turn to a violet or blue; 2, those which turn brown; 3, those which are changed to a light yellow or grey; 4, those which undergo little or no change.

The first group comprises madder, cochineal, orchil, alkanet, and murexide. Madder reds are turned to an orange by hydrochloric acid, whilst the three next are not notably affected. Cochineal is turned by the potassa to a violet-red, orchil to a violet-blue, and alkanet to a decided blue. Lac-dye presents the same reactions as cochineal, but has less brightness. Ammoniacal cochineal and carmine may likewise be distinguished by the tone of the reds obtained.

A characteristic of madder reds is that, after having been turned yellow by hydrochloric acid, they are rendered violet on treatment with milk of lime. A boiling sor

lye restores the original red, though somewhat paler. Artificial alizarine gives the same reaction. Turkey-reds, however, are quite unaffected by acid. Garancine and garanceux reds, if treated first with hydrochloric acid and then with milk of lime, turn to a dull blue.

Madder dyes are sometimes slow in being turned to a violet by potassa, and this shade when produced is often brownish. They might thus be confounded with the dyes of the fourth group, *i.e.*, rosolic acid, coralline, eosine, and coccine. None of these colours gives the characteristic reaction with milk of lime and boiling soap-lye. If plunged in milk of lime they resume their rose or orange shades, whilst the madder colours become violet. Murexide is turned, by potassa, grey in its light shades and violet in its dark ones. It might, then, be confounded with orchil, but it is decolourised by hydrochloric acid, which leaves orchil a red. Moreover it is turned greenish by stannous chloride.

A special character of this dye (murexide) is the presence of mercury, the salts of which serve as mordants for fixing it, and may be detected by the ordinary reagents.

The second group comprises merely santal-wood or sanders red, which turns to a brown. On boiling it with copperas it becomes violet, whilst on boiling with potassium dichromate it changes to a yellowish brown.

The third group includes safflower, magenta, and murexide (light shades). If the action of the potassa is prolonged the (soft) red woods enter into this group. Safflower turns yellow by the action of potassa, and the original rose shade is not restored by washing with water. Hydrochloric acid turns it immediately yellow. Citric acid has no action. Magenta is completely decolourised by potassa, but a prolonged washing in water reproduces the original shade. This reaction is common to many aniline colours. These decolourations and recolourations are easily produced in dark shades, whilst in very light shades they are less easily observed because there is always a certain loss of colour. Stannous chloride turns magenta-reds to a violet. Hydrochloric acid renders them yellowish brown (afterwards greenish?). Water restores the purple-red shade.

The fourth group comprises saffranine, azo-dinaphthyl diamine, rosolic acid, coralline, pure eosine, and eosine modified by a salt of lead, coccine, artificial ponceau, and red-wood.

Saffranine is detected by the action of hydrochloric acid, which turns it to a beautiful blue; the red colour is restored by washing in water. Azo-dinaphthyl diamine is recognised by its peculiar orange cast, and is turned by hydrochloric acid to a dull dirty violet. Rosalic acid and coralline, as well as eosine, are turned by hydrochloric acid to an orange-yellow: the two former are distinguished from eosine by their shade, which inclines to a yellow. Potassa turns rosolic acid and coralline from an orange-red to a bright red, whilst it produces no change in eosine. If the action of potassa is prolonged, modified eosine is blackened in consequence of the decomposition of the wool, the sulphur of which forms lead sulphide. Coccine becomes of a light lemon-yellow on treatment with hydrochloric acid. Washing with water restores the original shade. It affords the same reactions as eosine, but its tone is more inclined to an orange.

Artificial ponceau does not undergo any change on treatment with hydrochloric acid, and resists potash. Red-wood shades are turned towards a gooseberry-red by hydrochloric acid, especially if strong. This last reaction not being very distinct, red-wood shades might be mistaken for those of artificial ponceau but for the superior brightness of the latter. If the action of potassa is prolonged the red-wood shades are decolourised, and a washing with water then bleaches the tissue. Rocelline affords the same reactions as artificial ponceau, but if steeped in a concentrated solution of stannous chloride it is in time completely discharged, which is not the case with artificial ponceau.

Violet Colours.

Violets are divided into two groups: those affected by potassa, and those upon which it has no action. The first group embraces logwood, orchil, alkanet, and aniline violets, including under the latter term Perkin's violet (probably the original "mauve"), dahlia, Parme or magenta violet, methyl and Hofmann's violets. The action of potassa gives indications for each of these violets. Logwood violet is browned; that of orchil, if slightly reddish, is turned to a blue-violet; that of alkanet is modified to a fine blue. Lastly, Perkin's mauve, dahlia, and methyl violet become of a greyish brown, which may be re-converted into a fine violet by washing in abundance of water. When the shades are very heavy this greyish brown is almost of a violet-brown, so that the violets might seem to be unaltered.

The action of hydrochloric acid distinguishes these colours better still if the aid of ammonia is called in for two cases. The acid turns logwood violet to a fine red, and equally reddens orchil violet. But the two colours cannot be confounded, firstly, because the two violet shades are very distinct, that of orchil being much the brighter; and secondly, because ammonia has no action on logwood violet, whilst it turns orchil violet, if at all reddish, to a blue shade. Hydrochloric acid, whether dilute or concentrated, is without action on alkanet violet. If the acid is dilute it is equally without action on Perkin's violet and dahlia. If it is strong it turns them blue, and even green if in excess. Hofmann's violet turns green even with dilute acid, but prolonged washing restores the original violet shade. Dahlia gives a more blue shade than Perkin's mauve. The action of acid is equally characteristic for methyl violet. It becomes green, then yellow. Washing in water re-converts it first to a green, and then to a violet.

The second group includes madder violet, cochineal violet, and the compound violet of cochineal and extract of indigo. These three dyes are thus distinguished:—Hydrochloric acid turns the madder violet-orange, slightly brownish, or a light brown, and it affords the characteristic reaction of the madder colours described above under Reds. Cochineal violets are reddened. Sometimes they are decolourised, and become finally yellow, but do not pass through a brown stage.

The compound violet of cochineal and extract of indigo presents this characteristic reaction, that if boiled with very weak solution of sodium carbonate the liquid becomes blue, rather greenish, whilst the cloth becomes a vinous-red.—*Moniteur Scientifique*.

(To be continued.)

DETERMINATION OF POTASSA IN MANURES.

By M. E. DREYFUS.

THE method generally adopted for the determination of potassa in manures, *i.e.*, the direct incineration of the sample, may in certain cases occasion considerable errors in consequence of the volatilisation of a portion of the potassium products.

To avoid this inconvenience the author proposes a preliminary treatment of the manure with sulphuric acid at 1.845 sp. gr., to convert potassium nitrate and chloride into the fixed sulphate. The sulphuric acid attacks the manure energetically, and much facilitates the incineration, which may be effected at a dark red heat. The ignited portion (10 grms.) is exhausted with boiling distilled water acidulated with hydrochloric acid, and the filtrate, when cold, is made up to 500 c.c. Of this solution 50 c.c., representing 1 grm. of the sample, are taken, and, after being heated until close upon ebullition, baryta-water is added until a strong alkaline reaction is obtained. The sulphuric and phosphoric acids, alumina, magnesia, &c.

are thus precipitated. The filtrate is heated to a boil, and mixed with ammonia and ammonium carbonate, to precipitate the excess of baryta in solution. The last traces of lime are eliminated by means of a few drops of ammonium oxalate. The filtrate is evaporated down on the water-bath, and the ammoniacal salts are expelled by carefully raising the temperature to dull redness. After having taken up the residue in distilled water it is treated with platinum chloride, and the potassium chloro-platinate obtained is reduced with oxalic acid. The quantity of potassa present in the manure can be calculated from the weight of platinum obtained.—*Bull. de la Soc. Chim. de Paris.*

ON THE ESTIMATION OF PHOSPHORIC ACID AS MAGNESIC PYROPHOSPHATE.*

By THOMAS S. GLADDING, A.M.

In a valuable paper on the determination of phosphoric acid as magnesian pyrophosphate (*Amer. Chem. Jour.*, vol. 1, 391) Gooch has demonstrated that this method, far from being as accurate as is generally supposed, is peculiarly liable to sources of error, which cause a considerable over-estimation of the phosphoric acid actually present.

The great importance of this analytical determination from a commercial point of view gives enhanced interest to any enquiry as to its accurate execution. In view of the vast capital at present engaged in the conversion of phosphatic materials into artificial fertilisers, and in view of the fact that chemists frequently differ so widely in this important determination, the necessity, both for the interests of commerce and the credit of science, of an accurate and rigid method can be clearly understood. In the case of large and valuable cargoes sold upon chemical analysis, the slight error of even $\frac{1}{10}$ of a per cent in the estimation of phosphoric acid causes a difference in value ranging from twenty-five up to 200 dollars.

I have been led by these considerations to a careful examination of the modes of procedure at present recommended by the best authorities and which are in common use among chemists.

In the latest American edition of "Fresenius's Quant. Analysis" the directions are, to add to the neutral or moderately ammoniacal solution of the phosphate, magnesia mixture in slight excess, and after letting stand for some time, $\frac{1}{2}$ its volume of strong ammonia solution. In the case of a previous precipitation as phospho-molybdate of ammonia, this precipitate is dissolved in weak ammonia and the neutral or slightly ammoniacal solution treated as above.

The method recommended by the convention of chemists of the different experimental stations of Germany (held in Dec., 1881) is translated as follows:—(*Zeit. für Anal. Chem.*, 21, p. 290). "The beaker glass is now placed under the funnel, the filter pierced with a platinum wire, the precipitate washed into the beaker glass with 2½ per cent ammonia liquor, and dissolved by stirring with a glass rod, and then enough of the 2½ per cent ammonia liquor added to bring the volume of the liquid up to about 75 c.c. To 0.1 grm. phosphoric acid, 10 c.c. magnesia mixture are now dropped in, accompanied by a constant stirring up." In a foot-note is added "a gradual addition of the magnesia mixture is advisable under all circumstances, even when the ammoniacal solution of the molybdate precipitate is previously nearly neutralised by addition of hydrochloric acid." This mode of procedure differs from that given in "Fresenius" principally in the one point of insisting on a gradual addition of the magnesia mixture. In both methods a strongly ammoniacal magnesia mixture

is employed, and this is added to a more or less strongly ammoniacal solution of the phosphate.

On the other hand, the method giving the best results in the hands of Gooch consisted in the addition of a neutral magnesia mixture to a neutral solution of the phosphate, or still better, especially in the case of a previous precipitation as molybdic salt, in a double precipitation of the ammonia-magnesia-phosphate.

In testing the above methods great care was exercised in the preparation of the standard solutions. These were made by the use of chemically pure microcosmic salt. Upon careful ignition of this salt in a covered platinum capsule 5.1415 grms. gave 2.5110 grms. of phosphate of soda as residue, or 34.00 per cent of phosphoric acid against 33.98 per cent required by theory. With this salt, two solutions were prepared, the one containing 4.121 grms. of the salt in a litre or 0.035 grm. P_2O_5 in every 25 c.c., the other 20.605 grms. to a litre or 0.175 grm. of P_2O_5 in every 25 c.c. 25 c.c. were measured off with great accuracy by means of a pipette holding exactly 25 c.c. by careful weight test, when filled to the mark. This was then carefully rinsed out. The small neck of the pipette makes it easy to measure a liquid to within $\frac{1}{100}$ c.c. by this method. In addition to the experiments made with these solutions, others were made by direct weighings of the microcosmic salt.

METHOD I.

To the solution of the phosphate, diluted to 50 c.c. and made slightly alkaline by the addition of $\frac{1}{2}$ c.c. of ammonia liquor, the regular ammoniacal magnesia chloride mixture was added, 4 c.c. to every 25 c.c. of solution I., and 18 c.c. to every 25 c.c. of solution II. After letting stand for 15 minutes, 25 c.c. of strong ammonia solution were added, and the liquid filtered off after about 30 minutes. The washing was performed with strong ammonia solution, and was continued until 10 drops of the washings gave no precipitate with silver nitrate when acidified. In these and all subsequent experiments the filter-papers were each weighed, that an accurate weight allowance might be made for filter ash, and the precipitate was strongly ignited over a blast lamp for several minutes, until white. Two series of experiments were made, the one without a previous precipitation as phospho-molybdate of ammonia, the other with such previous precipitation.

A.—Without previous precipitation as molybdate salt.

	Amount taken.	Mg ₂ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1.	25 c.c. sol. I.	0.0559	0.0350	0.03575	2.14 p.c.
2.	"	0.0557	"	0.03563	1.80 "
3.	"	0.0559	"	0.03575	2.14 "
4.	"	0.0557	"	0.03563	1.80 "
5.	25 c.c. sol. II.	0.2770	0.1750	0.17718	1.25 "
6.	"	0.2763	"	0.17673	0.99 "
7.	"	0.2760	"	0.17654	0.88 "
8.	"	0.2762	"	0.17666	1.95 "

Average error 1.50 per cent.

B.—With previous precipitation as molybdate salt.

	Amount taken.	Mg ₂ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1.	25 c.c. sol. I.	0.0559	0.0350	0.03575	2.14 p.c.
2.	"	0.0559	"	0.03575	2.14 "
3.	"	0.0558	"	0.03569	1.97 "
4.	"	0.0556	"	0.03555	1.57 "
5.	25 c.c. sol. II.	0.2768	0.1750	0.17705	1.17 "
6.	"	0.2780	"	0.17782	1.61 "
7.	"	0.2774	"	0.17744	1.40 "
8.	"	0.2776	"	0.17756	1.46 "

Average error 1.68 per cent.

METHOD II.

The same course was followed as in method I., excepting that the solution of phosphate was exactly NEUTRALISED before the addition of the magnesia mixture.

* From the *Journal of the American Chemical Society*. Communicated by the Author.

A.—Without previous precipitation as molybdate salt.

Amount taken.	Mg ₃ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1. 25 c.c. sol. I.	0.05570	0.0350	0.03563	1.80 p.c.
2. "	0.05570	0.0350	0.03563	1.80 "
3. 25 c.c. sol. II.	0.2758	0.1750	0.17641	0.81 "
4. "	0.2757	0.1750	0.17635	0.77 "
5. "	0.2753	0.1750	0.17609	0.62 "

Average error 1.16 per cent.

B.—With previous precipitation as molybdate salt.

Amount taken.	Mg ₃ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1. 25 c.c. sol. I.	0.0556	0.0350	0.03555	1.57 p.c.
2. "	0.0556	0.0350	0.03555	1.57 "
3. 25 c.c. sol. II.	0.2770	0.1750	0.17718	1.25 "
4. "	0.2772	0.1750	0.17731	1.32 "

Average error 1.43 per cent.

METHOD III.

To the solution of phosphate, 75 c.c. in volume and quite strongly ammoniacal, the magnesia mixture was added at the rate of one drop a second, the contents of the beaker being kept in constant rotation. The magnesia mixture was added from a burette, the rapidity of flow being regulated by a glass cock, or still better from an ordinary Mohr burette, the flow being regulated by a screw-clamp. The beaker was slightly inclined, so as to receive the drops on its side. The magnesia mixture by this arrangement flowed down the side of the beaker in a thin stream and an exceedingly gradual admixture with the phosphate solution was thereby secured. After the addition of the magnesia mixture, 25 c.c. of strong ammonia were added and the whole allowed to stand for two or three hours. Very strong ammonia water was used in the washing, as in several cases a tendency to run through the filter-paper was observed, when a weaker ammonia solution happened to be employed. One part concentrated ammonia water to three parts water was employed.

A.—Without previous precipitation as molybdate salt.

Amount taken.	Mg ₃ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1. 25 c.c. sol. I.	0.0547	0.0350	0.03499	0.00 p.c.
2. "	0.0547	0.0350	0.03499	0.00 "
3. 25 c.c. sol. II.	0.2736	0.1750	0.17500	0.00 "
4. "	0.2735	0.1750	0.17494	0.03 "
5. "	0.2738	0.1750	0.17513	0.07 "
6. 0.5231 g. } micro. salt }	0.2775	0.17775	0.17750	0.14 "
7. 0.5120	0.2717	0.17397	0.17379	0.10 "

Average error 0.05 per cent.

B.—With previous precipitation as molybdate salt.

Amount taken.	Mg ₃ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1. 25 c.c. sol. I.	0.0548	0.0350	0.03505	0.14 p.c.
2. "	0.0548	0.0350	0.03505	0.14 "
3. 25 c.c. sol. II.	0.2736	0.1750	0.17500	0.00 "
4. "	0.2734	0.1750	0.17488	0.07 "
5. "	0.2732	0.1750	0.17475	0.14 "
6. "	0.2733	0.1750	0.17481	0.11 "

Average error 0.10 per cent.

METHOD IV.

To the solution containing the phosphate, either neutral or ammoniacal, the magnesia mixture was added, and then 25 c.c. of concentrated ammonia water. After letting stand for thirty minutes, the liquid was filtered off and the precipitate thoroughly washed on the paper. The precipitate was then dissolved on the paper with dilute HCl and washed into the original beaker. 25 c.c. of concentrated ammonia solution were now added to the filtrate, no care being taken to add it gradually. After the flocculent precipitate had settled, 5 c.c. magnesia mixture

were added, and the whole allowed to stand for several hours. The second precipitation was found to be incomplete without the addition of this extra magnesia mixture.

A.—Without previous precipitation as molybdate salt.

Amount taken.	Mg ₃ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1. 25 c.c. sol. II.	0.2736	0.1750	0.1750	0.00 p.c.
2. "	0.2735	0.1750	0.17494	0.03 "
3. "	0.2736	0.1750	0.17500	0.00 "
4. 0.5095 g. } micro. salt }	0.2712	0.17313	0.17336	0.13 "
5. 0.5703 "	0.3030	0.19379	0.19380	0.00 "
6. 1.0108 "	0.5372	0.34347	0.34361	0.04 "

Average error 0.03 per cent.

B.—With previous precipitation as molybdate salt.

Amount taken.	Mg ₃ P ₂ O ₇ found.	P ₂ O ₅ required.	P ₂ O ₅ found.	Error.
1. 25 c.c. sol. II.	0.2738	0.1750	0.17512	0.07 p.c.
2. "	0.2736	0.1750	0.1750	0.00 "

Average error 0.035 per cent.

Still another method was investigated as follows:—To the neutral solution of phosphate was added a neutral magnesia mixture in slight excess. No precipitate appeared except in the case of very concentrated solutions. An extremely weak ammonia water was then added, drop by drop, to the liquid, to which was imparted at the same time a constant rotary motion. An exceedingly granular, pure precipitate was thus produced. The results obtained were perfectly accurate, but as the precipitate was very light and apt to fly, when removed from the paper into the capsule, for ignition, and as the method involved the extra labour over Method III. of first neutralising the solution, it was not carried out in full.

A series of determinations by these several methods, on different fertilisers received in the course of business, was also carried out. The average error is calculated from the results obtained by Method IV., regarded as correct.

Fertiliser.	Method I. P ₂ O ₅ p.c.	Method II. P ₂ O ₅ p.c.	Method III. P ₂ O ₅ p.c.	Method IV. P ₂ O ₅ p.c.
Superphosphate	10.88			10.50
"		9.49	9.38	9.37
Acid phosphate	14.65			14.20
"	15.20			14.75
Tankage	16.96			16.06
"		16.86		16.44
Bone-meal	22.20			21.60
"		21.83		21.51
Rock phosphate	25.15	24.96		24.45
"		28.93	28.32	28.39
Bone-ash	30.25		29.76	29.80
Bone-black			34.39	34.33
Average error.	0.56 per cent.	0.36 per cent.	0.04 per cent.	

A study of these results demonstrates that the common method of precipitation as carried out under Methods I. and II. will invariably give results too high. In fertiliser work the error thus introduced will vary all the way from one or two tenths of a per cent when the solution is carefully neutralised and when it chances to be very dilute, up to six tenths per cent or even higher when the solution is more concentrated, or when molybdate of ammonia is present, or where the solution is strongly or even moderately ammoniacal when the magnesia mixture is added. This great variation of error undoubtedly explains many of the differences that have occurred in the analyses of different chemists. The errors thus obtained clearly arise from the too sudden formation of the ammonia-magnesia phosphate precipitate, the precipitate carrying down with it extraneous matter, the error increasing, of course, when a large amount of molybdate of ammonia is present.

When no foreign matter is present and the exact theoretical amount of magnesium chloride is contained in the solution, this sudden precipitation is not injurious, as is seen in Method IV. Method III. when carried out as here described gives accurate results even in the presence of molybdate of ammonia. This method, as it does not necessitate any previous neutralisation of the solution with hydrochloric acid, and requires but one precipitation, is the one to be most highly recommended. Strong ammonia water should be added in liberal amount to the solution, and also employed in the washing.

The breaking of the filter-paper and washing of the molybdate salt in the beaker, without filtering the solution, cannot be recommended. However thoroughly the yellow salt may be washed, there is always a slight residue insoluble in ammonia water. A solution and filtration of the molybdic precipitate is therefore necessary in accurate work.

NOTES OF WORK BY STUDENTS OF
PRACTICAL CHEMISTRY
IN THE
LABORATORY OF THE UNIVERSITY OF
VIRGINIA.

No. XI.

Communicated by J. W. MALLETT,
Professor of General and Applied Chemistry in the University.
(Concluded from p. 206.)

(88.) *Analysis of a Mineral allied to Orthite, from the same locality as the last.* By W. H. SEAMON.

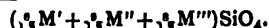
This mineral, also sent me by Mr. Hidden, occurs in fairly well defined flattened crystals, agreeing in form with orthite (allanite), imbedded in the soft kaolin of the Wiseman mica mine. The colour is pitch-black, with sub-metallic lustre. Streak brownish grey. Imperfect conchoidal fracture. Hardness = 6. Sp. gr. = 3.75. Analysis gave—

SiO ₂	..	..	..	..	..	39.03
Al ₂ O ₃	..	..	..	..	..	14.33
Y ₂ O ₃	..	..	..	..	..	8.20
Ce ₂ O ₃	..	..	..	..	..	1.53
Fe ₂ O ₃	..	..	..	..	..	7.10
FeO	..	..	..	..	..	5.22
MgO	..	..	..	..	..	4.29
CaO	..	..	..	..	..	17.47
H ₂ O	..	..	..	..	..	2.78

99.95

The absorption-spectrum of the Y₂O₃ in concentrated solution gave no distinct evidence of the presence of Eb, Yb, &c., and Di and La were present in but minute amount.

These results correspond to an ortho-silicate in which the hydrogen of the water is probably to be taken as basic, and in which the distribution of basic elements is pretty closely—



The mineral exhibits, however, as to its individual constituents, a very unusual variety of this extremely variable species. The amount of cerium, &c., is extraordinarily low, contrasting strikingly with the proportion found in the mineral from Bedford Co., Va., the analysis of which is given above (79). The yttrium group is, on the contrary, represented in notable quantity, while the amounts of calcium and magnesium found are much larger than usual.

(89.) *Examination of a New Sulphide received as Fahlerz, from the "Great Eastern Mine," Park Co., Colorado.* By W. T. PAGE.

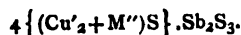
The general appearance of the specimen in question was that of Fahlerz. It seemed to be quite homogeneous,

except that it was somewhat interpenetrated by gangue. The colour was steel-grey, with metallic lustre and dark red streak. Crystalline structure, but no faces that could be identified. Brittle, with uneven fracture. Hardness = about 4. Sp. gr. = 4.89. Fusible before the blowpipe flame, with production of antimonial fumes. A careful analysis gave—

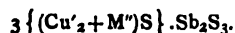
S	..	..	..	..	..	26.88
Sb	..	..	..	..	..	34.47
Cu	..	..	..	..	..	23.20
Zn	..	..	..	..	..	7.14
Fe	..	..	..	..	..	1.38
Pb	..	..	..	..	..	1.19
Siliceous residue	..	..	..	..	..	5.86

100.12

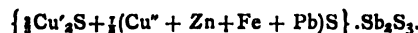
These numbers correspond, not with the tetrahedrite formula—



but with that of Bournonite and Stylotypite,—



The mineral now reported on is, however, peculiar in containing copper, *one half as cuprous and one half as cupric sulphide*, with little lead and iron, but a notable amount of zinc. The analysis agrees with the formula—



The mineral might as well be considered a distinct species as stylotypite, but it is probably better to avoid multiplication of names, and to consider both merely as varieties of Bournonite.

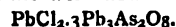
(90.) *Analysis of Colourless Mimetite from the "Richmond" Mine, Eureka, Nevada.* By F. A. MASSIE, of the University of Virginia.

The specimen consisted of slender, almost acicular, hexagonal prisms, aggregated into a fragile mass, with a few small crystals of wulfenite scattered through it. The individual crystals were colourless and transparent, with adamantine lustre and white streak; the general aspect of the mass very much like that of cerussite. Hardness = about 3. Sp. gr. = 6.92. Very easily fusible. Analysis gave—

As ₂ O ₅	..	..	..	..	..	23.41
P ₂ O ₅	..	..	..	..	..	trace
PbO	..	..	..	..	..	68.21
PbCl ₂	..	..	..	..	..	8.69

100.31

in accordance with the well known formula—



(91.) *Examination of Gold, Silver, &c., Alloys found in grains along with the Native Platinum of Colombia, S. America.* By W. H. SEAMON.

Some years ago I had an opportunity of picking over, with the aid of a lens, two pretty large parcels of South American native platinum, and selecting for examination a number of grains which had not the appearance of platinum or osmium-iridium. These grains of foreign material were examined by Mr. Seamon, who first carefully separated those presenting visible difference of external character. In doubtful cases single grains only were submitted to analysis. Quartz, pyrite, chalcocopyrite, and one or two particles of platinum of unusual surface colour were identified, but the principal material consisted of about a gramme of metallic grains which, on being separated, gave the following results:—

(a) Rough, flattened grains, of greenish yellow colour and metallic lustre. Sp. gr. = 15.4. Consisted of—

Au	..	..	..	..	84.38
Ag	..	..	..	..	13.26
Cu	..	..	..	..	1.85
Pt	..	..	..	..	trace*

99.49

* Probably mechanically imbedded.

or pretty nearly—

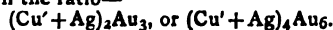


(b) One grain, nearly spherical, of greenish yellow colour, metallic lustre, and sp. gr. = 15.63, consisting of—

Au	..	..	..	..	80.12
Cu	..	..	..	..	15.84
Ag	..	..	..	..	2.27
Fe	..	..	..	..	trace

98.23

or nearly in the ratio—

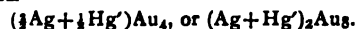


(c) Rounded microscopic nuggets, of honeycombed structure, light yellow colour, bright metallic lustre, and sp. gr. = 15.8, consisting of—

Au	..	..	..	..	84.01
Ag	..	..	..	..	7.66
Hg	..	..	..	..	7.06

98.73

or nearly—



(d) Lenticular grains of gold-yellow colour, bright metallic lustre, and sp. gr. = 15.51, yielding—

Au	..	..	..	..	93.12
Ag	..	..	..	..	4.78

97.90

(e) Rough grains, of very small size, one of which was nearly spherical. Of gold-yellow colour and metallic lustre. Sp. gr. undetermined. Consisted of—

Au	..	..	..	..	about 91.00
Ag	..	..	..	..	" 9.00

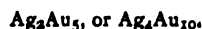
100.00

(f) Rough yellow grains, with microscopic reddish spots on the surface, of full metallic lustre, and sp. gr. = about 15, consisting of—

Au	..	..	..	..	82.00
Ag	..	..	..	..	17.70
Cu	..	..	..	..	trace

99.70

or nearly—



The specific gravity determinations are not of much value, on account of the very small scale on which the weighings had to be made. Careful qualitative search was in each case made for the metals of the platinum group. A gold, silver, and mercury alloy from this region, though with more mercury than occurs in (c) has been already described. I have never seen mentioned a native alloy of gold and copper with nearly so large a proportion of copper as in (b).

(92.) Analysis of Native Palladium-Gold from Taguaril, near Subara, Province of Minas Geraes, Brazil. By W. H. SEAMON.

It seems that the native gold alloyed with palladium ("ouro preto"), which formerly was collected in considerable quantity in Brazil, is now scarcely ever received at the Rio de Janeiro Mint, and is merely washed out from river gravels in a very small way by the poorest class of labourers working on their own account. I am indebted to Prof. Orville A. Derby, Director of the Geological Survey of Brazil, for special trouble taken in procuring

me a good specimen of this alloy in the district in which it occurs.

The gold is quite finely divided, much of it true gold dust, the grains of larger size flaky. It has the characteristic dark or bronze-like colour due to the presence of the palladium. Sp. gr. = 15.73. Analysis gave—

Au	..	..	..	..	91.06
Pd	..	..	..	..	8.21
Ag	..	..	..	..	trace
Fe	..	..	..	..	trace*

99.27

* Apparently as mechanically adherent Fe₂O₃.

Taking the atomic weights of gold and palladium as usually accepted, these results correspond almost exactly to the formula—



(93.) On the Composition of Two Specimens of Jade. By C. L. ALLEN, of Charleston, South Carolina.

(a) The former of these two specimens has some degree of special interest, as having come from one of the quarries formerly worked by the Chinese in the Karakash Valley, on the southern borders of Turkistan, representing, therefore, Chinese jade from one of its original sources. The specimen was received from the Museum of the Indian Geological Survey at Calcutta, and had been brought back among the collections of the Yarkand Embassy. The circumstances of occurrence of the mineral, and the condition of the old workings when visited have been described by Dr. Ferd. Stoliczka, naturalist, attached to the Embassy.* He says that these quarries, in the Kuenlun Mountains, must have yielded a considerable portion of the jade of Chinese commerce, and have been known to the Chinese for the last 2000 years, their working having, however, been discontinued since the expulsion of these people from Yarkand in 1864.

The mineral forms a compact, extremely tough mass, of very pale sea-green colour, and lustre between vitreous and pearly; streak white. Translucent. Hardness = 6.5. Sp. gr. = 2.98. Analysis gave—

SiO ₂	..	..	..	..	57.35
Al ₂ O ₃	..	..	..	..	1.03
FeO	..	..	..	..	1.22
MgO	..	..	..	..	22.73
CaO	..	..	..	..	13.40
Na ₂ O	..	..	..	..	0.25
K ₂ O	..	..	..	..	0.23
H ₂ O	..	..	..	..	2.69

98.90

(b) The other specimen consisted of fragments from larger masses which had been ground and polished, and came from Hokotika, on the west side of the South Island, New Zealand, purchased from Ward and Howell, Rochester, N.Y., having been brought from New Zealand by Mr. Ward not long since.

This specimen also represented a very tough, compact substance, but of various shades of green colour, mostly dark, with lustre between vitreous and pearly; streak white. Sub-translucent. Hardness = a little over 6. Sp. gr. = 3.026. The purest portions, of uniform dark leek-green colour, were selected for analysis, which gave—

SiO ₂	..	..	..	..	56.34
Al ₂ O ₃	..	..	..	..	1.60
FeO	..	..	..	..	4.86
MgO	..	..	..	..	20.23
CaO	..	..	..	..	13.51
Na ₂ O	..	..	..	..	0.27
K ₂ O	..	..	..	..	0.31
H ₂ O	..	..	..	..	3.57

100.69

* Records of the Geological Survey of India, vol. vii., pt. 2, p. 51 (1874).

It is obvious that both these specimens represent the "nephrite" variety of amphibole, not the aluminous "jadeite" of Damour. (a) corresponds essentially to the meta-silicate—



and (b) to—



In the former nearly all, in the latter about two-thirds, of the hydrogen of water found seems to be basic.

(94.) *On the Occurrence of Nitrites in Human Saliva.* By R. N. MUSGRAVE.

It has been stated by Schönbein* that ordinary mixed saliva usually, but not always, gives the reaction for nitrites with starch-paste, potassium iodide, and dilute sulphuric acid. In connection with a research carried out for the U.S. National Board of Health on the methods for the determination of organic matter in potable water,† I was led to think of re-examining this point, having come to suspect the possibility of an organised nitrifying ferment being the cause of disease from the use of certain waters in which nitrites and nitrates were prominently detectable, though the quantity of organic matter was small, while Dr. Sternberg, U.S.A.,‡ had observed marked, even fatal, effects upon rabbits from the sub-cutaneous injection of some specimens of human saliva. Mr. B. H. Heyward had last year examined under my direction into the occurrence of ammonia in saliva,§ and found it present in all the cases examined, thus suggesting a possible source for the production of nitrites and nitrates under the influence of organised ferments in the secretion in question. Mr. Musgrave undertook to investigate the occurrence of nitrites, and, although his work was cut short before it had covered the ground intended, the following results were obtained, which deserve to be recorded:—

The admirably delicate test of Griess—sulph-anilic acid followed by naphthylamin hydrochlorate in an acidified solution—was employed, and quantitatively applied by comparison of the colour produced under precisely similar conditions by the saliva on the one hand, and a standard (extremely dilute) solution of pure potassium nitrite on the other. Due care was taken to avoid error from nitrites derived from the air. Examining at about the same hour of the day—10 to 11 a.m.—the mixed saliva of different individuals—all young men, students, in good health—the results were:—

Parts of Nitrogen as Nitrites per million of Saliva.

First person	2.0
Second person	0.7
Third person	0.8
Fourth person	0.4
Fifth person	0.4
Sixth person	1.3
Seventh person	0.8
Eighth person	1.0
Ninth person	1.2
Tenth person	1.2
Eleventh person	0.9
Twelfth person	1.6

The results varied on different days for the same person: thus, on other days than those of the above experiments, the first person gave 1.6 parts per million, and the second person 1.3 parts. Apparently there was a relation between the interval of time from meals and the results obtained. Thus, in the case of the first person in the list, on one day the results were—

	Pts. per million.
Before breakfast	0.0
After breakfast (10 to 11 a.m.)	2.2
Later (1 to 2 p.m.)	1.3

And on another day—

Before breakfast	0.7
After breakfast (10 to 11 a.m.)	1.6

While the third person in the list gave—

Before breakfast	0.0
After breakfast (10 to 11 a.m.)	0.8

It had been intended to examine the secretions of the different salivary glands separately, but this was not done.

It will be observed that the amount of nitrogen found as nitrites is much less than that as ammonia, Mr. Heyward having determined quantities of the latter varying from 30 to 100 parts per million.

University of Virginia,
August 30, 1882.

ON SAUER'S METHOD OF ESTIMATING
SULPHUR, AND SOME MODIFICATIONS.

By W. G. MIXTER.

SEVERAL years ago, A. Sauer* and the writer† proposed methods for determining sulphur in coals and organic compounds by burning in oxygen and oxidising the sulphur dioxide with bromine. The former passed the products of combustion through two U-tubes containing a hydrochloric acid solution of bromine, and the latter burned in a confined volume of moist oxygen and a little bromine vapour. The writer stated that experiments made by passing the products of combustion of sulphur compounds through nitric acid failed to give satisfactory results. A variable loss was due to a dense white fume containing sulphuric acid, which was not completely absorbed by water or by caustic alkalis. It was mentioned that the apparatus employed was designed to avoid this source of error.

With the hope that Sauer's method or some simple modification of it would give satisfactory results, the following experiments have been made. For the burning of volatile substances, Sauer's plan of a doubly perforated rubber stopper in the anterior end of the combustion-tube did not seem desirable, as some sulphuric acid is liable to condense with the water against this stopper; or in case little water is present, some strong sulphuric acid may come in contact with the rubber; hence oxygen was passed through the small hard glass tube *a*, fig. 1, to *c*. Carbonic acid or air was passed in very slowly through *b* during the volatilisation of the assay to prevent the condensation in the cold anterior end of the combustion-tube. After all volatile matters had burned, the rubber tubes, connecting with the oxygen and carbonic acid supplies, were closed by clamps and reversed, so that on opening the clamps oxygen passed through *b*, and a very slow current of carbonic acid through *a*. The products of combustion were passed through two U-tubes, such as figured by Sauer, containing a solution of bromine in a mixture of one part of fuming hydrochloric acid and two parts of water. In order to find whether the cloud which issues from the U-tubes contains sulphur, it was passed by means of a glass tube to near the bottom of an eight-litre bottle. This cloud or fume usually has a well defined surface, which seldom rises above the middle of the bottle. After the cloud completely subsided, the bottle was rinsed three times with water, and the sulphur was precipitated as barium sulphate. Sauer's plan for non-volatile substance was tried, with the addition of the large bottle above described. In all the experiments the rinsings of the

* *Journ. für Prakt. Chem.*, 86, 151.

† *Bulletin of the U.S. National Board of Health*, Suppl. No. 19, (May 27, 1882).

‡ *Same Bulletin*, No. 44 (April 30, 1881), and Suppl. No. 14 (July 23, 1881).

§ *CHEMICAL NEWS*, vol. xlv., p. 208.

* *Fres. Zeit.*, 12, 32.

† *Amer. Jour. Sci. and Arts*, 3rd. series, 4, 90.

combustion-tube were added to the solutions from the U-tubes.

	I.	II.
Pure sulphur taken ..	0.2010	0.2638
Total sulphur found ..	99.69 per cent.	99.85 per cent.
Sulphur found in bottle ..	0.89 "	0.25 "
Time of burning ..	1 hour.	15 minutes.

About four times as much oxygen and carbonic acid were used in I. as in II.

	I.	II.
Coke	2 grms.	2 grms.
Total sulphur found in gaseous products ..	0.79 per cent.	0.78 per cent.
Sulphur found in bottle ..	0.13 "	1.17 "

In order to find whether there is any loss of sulphur in estimating it by this method in substances like coke, a mixture of sugar charcoal and pyrite, FeS_2 , containing a known amount of sulphur,* was tried.

time of the actual burning of each of the assays was about three-quarters of an hour.

In the two following experiments the products of combustion were passed through 75 c.c. of fuming hydrochloric acid, saturated with bromine, distributed in three bulbs of an absorbing apparatus, each bulb having a capacity of 200 c.c., and so arranged that the gases bubbled through the liquid in each bulb and finally passed into the large bottle. The apparatus was made entirely of glass to avoid any question of sulphur from rubber connections. The burning in each test occupied about three-quarters of an hour. The results show that about two parts in one hundred parts of sulphur used were not absorbed by the bromine solution.

Charcoal	2	2	grms.
Pyrite	0.2058	0.219	"
Sulphur found in bottle ..	0.0018	0.0023	"

FIG. 1.

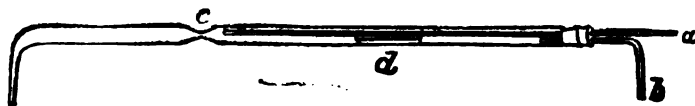
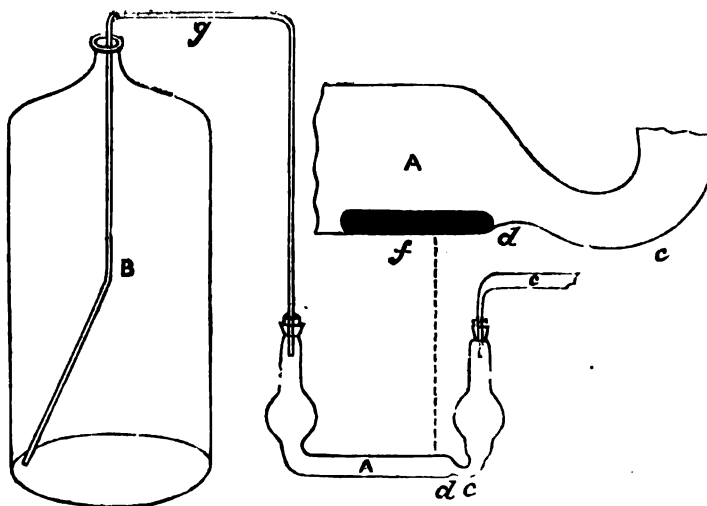


FIG. 2.



	I.	II.
Charcoal	2 grms.	2 grms.
Pyrite	0.2258 "	0.2057 "
Sulphur calculated ..	0.1199 "	0.1092 "
Total sulphur found ..	0.1198 "	0.1091 "
Sulphur found in bottle ..	0.0131 "	0.0099 "

The results show that in I. 99.91, and in II. 99.90 per cent was found of the sulphur taken, and that 11 per cent in I. and 9 per cent in two passed into the large bottle. No sulphur was found in the residue in the tray. The

* The pyrite was treated with cold nitric acid, and the whole was kept cool in water, and by constant agitation until only finely divided sulphur remained. On heating in a water-bath the sulphur disappeared and a complete solution resulted. The excess of acid was evaporated, the sulphur was precipitated as BaSO_4 , the precipitate was fused with sodium carbonate. The fused mass was washed and the sulphur was re-precipitated in the acidified filtrate.

	I.	II.	mean.
Pyrite taken	0.3230	0.3165	53.11
Per cent sulphur found ..	53.14	53.08	53.11

A hydrochloric acid solution of bromine is probably a no better absorbent of sulphur dioxide than bromine water, and is objectionable for the reason that the excess of hydrochloric acid must be evaporated so that some barium sulphate may not remain dissolved. Bromine water with a cubic centimetre or two of undissolved bromine, in a common two-bulb U-tube, loses bromine rapidly when gas bubbles through it, but when the liquid bromine mixes gradually with the water, the passing gas removes the bromine slowly. In the two following experiments, a four-bulb U-tube with two bulbs on the bottom was used. Two cubic centimetres of bromine were placed in the lower bulb next to the combustion-tube, and sufficient water was added to trap three of the bulbs. It was necessary to shake the U-tube occasionally during the combustion in order to keep bromine distributed through the water. The large bottle was used as before. A trace of sulphur found in the residues in the tray was weighed

with the total sulphur. The time of actual burning was about three-quarters of an hour.

	I.	II.	
Charcoal	2	2	grms.
Pyrite	0.2024	0.2087	"
Sulphur calculated	0.1075	0.1108	"
Total sulphur found	0.1071	0.1108	"
Sulphur found in bottle	0.0062	0.0026	"

These figures show that 99.63 and 100 per cent of the total sulphur taken was found, and that 5.77 and 2.35 per cent respectively condensed in the large bottle, and also that bromine water may replace a hydrochloric acid solution of bromine.

After experimenting with various forms of U-tubes, designed for keeping bromine distributed through the water during the passage of the gases from the combustion, the bulb tube A, shown in fig. 2, was found suitable for this purpose. It is about 30 c.m. long and 20 c.m. high, and is narrowed at the necks so that small rubber stoppers may be used. The enlarged part represents the full size of this portion of A. The slight elevation of the glass at d is to keep the liquid bromine, shown at f, from passing into the narrowed part e. A description of the manner of using this absorbing tube will make clear the reasons for the shape at d and e. It is first connected with the combustion-tube c, and a cubic centimetre of bromine is poured in and then water added to fill it to the bulbs, and the narrow glass tube g is adjusted. This tube g dips under a little water in B. A is then slightly inclined so that bubbles of gas from the combustion may slowly pass the lower limb. From time to time, as bromine disappears from the surface of the water, A may be inclined more so that a drop or two of bromine shall enter the narrow part e, where the passing gas mixes it thoroughly with the water. The remaining experiments were made in the apparatus above described, and the form of combustion-tube shown in fig. 1.

	I.	II.	
Sugar	0.670	1	grm.
Sulphur	0.2028	0.2777	"
Sulphur found	0.199	0.2747	"
Per cent of sulphur found	98.12	98.95	"

In I. a slight deposit of unburnt matter remained in the bend of the combustion-tube.

0.2783 grm. of pure carbon disulphide yielded 83.53 per cent of sulphur; theory requires 84.20. In another trial with carbon disulphide, free sulphur was found in the bromine water.

The first trial with cannel coal was a failure, owing to too rapid volatilisation. A light-coloured sticky substance containing carbon and a trace of sulphur was found in the bottle B. In a second experiment the combustion appeared to have been complete, and 3.1 per cent of sulphur was found in the volatile portion of the coal.

The results obtained show that Sauer's method is good if the sulphur which passes the bromine solution is caught in a large bottle. A much smaller bottle than the one used would probably stop all the sulphur, but an eight-litre bottle does not allow a troublesome amount of bromine to escape into the room; 150 c.c. of water are sufficient to rinse the bottle. Complete combustion can be insured by volatilising so slowly that the flame of the burning vapours remains a few millimetres back of the end of the tube delivering oxygen. Sauer's apparatus as modified by the writer, supposing a combustion furnace and gas-holders are at hand, has the advantage of simplicity and fewer connections over the plan proposed by the writer for burning in a confined space. Sauer's method requires double to treble the time for burning, and with volatile substances more care to insure complete burning than the writer's original method.—*American Chemical Journal.*

Detection of Spurious Honey.—H. Planta.—Fætidious honey gives a white precipitate if mixed with honey owing to the presence of dextrine.—*Deut. Apoth. Zeitung.*

PROCEEDINGS OF SOCIETIES.

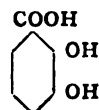
CHEMICAL SOCIETY.

Thursday, November 2, 1882.

F. A. ABEL, F.R.S., Vice-President, in the Chair.

It was announced that a ballot for the election of Fellows would take place at the next meeting (November 16). The following certificates were read for the first time:—F. W. Branson, J. S. Bishop, E. E. Berry, R. Blair, R. Coulthard, W. J. Chrystal, T. R. Cowie, R. Carruthers, E. G. Clayton, J. T. Dunn, H. L. Dampier, A. G. Earl, G. Gray, J. L. Howe, A. G. Howard, W. A. L. Hammersley, H. Hotblack, E. Jackson, A. E. Johnson, A. Keen, F. J. Kilner, J. D. McCarthy, H. E. Newton, T. F. Peppé, S. E. Phillips, R. H. Parker, S. Rideal, G. M. Taylor, T. E. Vasey.

Dr. A. K. MILLER then read a paper "On Dihydroxy-benzoic Acids and Iodo-salicylic Acids." Of the six possible dihydroxy-benzoic acids, five are already known, the sixth acid being represented by the formula—

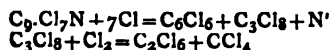


Two methods were tried for preparing this body. 1. Catechol was heated with concentrated solution of ammonium carbonate in sealed tubes for several hours. The product of the reaction consisted of a mixture of two acids, one of which was proto-catechuic acid; the other must be the acid sought for, as this and proto-catechuic acid are the only two dihydroxy-benzoic acids derivable from catechol. The above reaction gave a very poor yield, and a second method for preparing this catechol-orthocarboxylic acid was tried. Salicylic acid and iodine were heated together in alcoholic solution, and the resulting iodo-salicylic acids purified by crystallisation from water. The results obtained differ from those published by Lantemann, Liechti, Demole, &c. It was found that two iodo-salicylic acids had been formed: para-iodo-salicylic acid, melting at 197°, and a new isomer, melting at 198°. The two differed in crystalline appearance, solubility, &c., but most markedly in yielding two distinct dihydroxy-benzoic acids when heated with potash. From the former quinol-carboxylic acid was obtained, from the latter an acid, which split up on heating into carbonic anhydride and catechol. The fact of a dihydroxy-benzoic acid derived from salicylic acid, splitting up on heating into carbonic anhydride and catechol is of itself proof that it must have the constitution indicated above. This constitution is, however, the only one possible for the acid produced together with proto-catechuic acid by introducing a carboxyl group into catechol, and since a comparison of the products of both reactions has shown the two to be identical there can be no doubt that constitution given is the correct one.

The SECRETARY then read a paper "On Crystalline Molecular Compounds of Naphthalene and Benzene with Antimony Trichloride," by WATSON SMITH and G. W. DAVIS. On melting three parts by weight of antimony trichloride and two of naphthalene, minute but perfectly symmetrical clinorhombic tables formed in the liquid, after the source of heat had been removed. These crystals were separated with a warmed platinum spatula. They are very deliquescent, and have the composition 3SbCl₃.2C₁₀H₈. A similar compound is formed with benzene having the composition 3SbCl₃.2C₆H₆.

A second communication was also read by the SECRETARY, entitled "Additional Evidence, by an Analysis of the Quinoline Molecule, that this Base belongs to the Aromatic Series of Organic Substances," by WATSON SMITH and G. W. DAVIS. The authors have invest

the effect of an exhaustive perchlorination, according to the method of V. Merz, on quinoline. If this body has the constitution usually assigned to it, the portion of the compound nucleus containing nitrogen might be expected to be least stable, and to yield, when chlorinated, perchlorethane, perchlormethane, and nitrogen, whilst the other portion would yield perchlor-benzene.



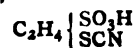
Pure quinoline was therefore heated in a strong tube of hard glass with ten times its weight of antimony pentachloride to 170° , then to 280° , to 320° , and finally to 400° , each for a space of five hours. After each heating the hydrochloric acid gas, and nitrogen were allowed to escape, an operation attended with some danger. A crystalline black mass was the result, which was washed out with hydrochloric acid, and the antimony separated. The residue was dried and sublimed. By re-sublimation, &c., perchlor-ethane, melting at 182° , and perchlor-benzene, melting at 223° , were separated. No perchlor-methane could be detected, but owing to its volatility it was probably carried off in the violent rushes of gas which took place on opening the tube.

The SECRETARY then communicated a paper "On Orcin and some of the other Di-oxy-toluols," by R. H. C. NEVILLE and Dr. A. WINTHER. Various considerations led the authors to the conclusion that orcin was a di-oxy-toluol of the constitution 1.3.5, a supposition which has since been shown to be true by Tiemann and Streng. The present research was undertaken to discover if possible some practicable method for the artificial production of orcin. The starting point was dinitro-toluol, 1.3.5, prepared from dinitro-para-toluidine the yield being 60 to 65 per cent. The dinitro-toluol was dissolved in an alcoholic solution of ammonium sulphide and water added, when an orange-red substance is precipitated. This was dissolved in dilute hydrochloric acid and reprecipitated by ammonia. The nitro-toluidin was purified, converted into nitro-kresol, which was reduced with tin and hydrochloric acid. The chloride was dissolved in a hot mixture of equal parts of sulphuric acid and water. The solution diluted with water, and a dilute solution of potassium nitrite added. The liquid was then warmed, filtered, and extracted with ether. The red-brown oil so obtained was purified by distillation, and the product by crystallisation furnished the di-oxy toluol identical in all respects with orcin. The authors have also prepared orcin from meta-bromo-toluol-meta-sulphonic acid, and from meta-dibromo-toluol. The authors have also prepared the di-oxy-toluol, 1.2.4 and 1.2.5, and have investigated the preparation of the body 1.3.4. They have tabulated the reactions of the various di-oxy-toluols with ammonia, chloride of lime, ferric chloride, &c.

"On the Varying Quantities of Malt Albumenoids Extracted by Waters of Different Types," by E. R. MORITZ and A. HARTLEY. The authors give tables showing the sp. gr. of the worts and the percentage of nitrogen extracted by distilled water, and waters containing NaCl, MgSO_4 , Na_2CO_3 , Burton crystals, $\text{Ca}(\text{NO}_3)_2$, &c. The experiments show that distilled water extracts the smallest amount of albumenoids; salt does not much increase the extractive power, but calcium salts, especially the nitrate, have a strong extractive power. The authors, however, conclude that the influence of the extracted albumenoids has been very much overrated, as the differences in results are comparatively insignificant. They attribute the characteristics of the finished produce to the direct influence of the mineral matters on fermentation, a subject which they are at present investigating.

Mr. WARRINGTON suggested that the authors might have carried their investigations further, and estimated the non-albumenoid as well as the albumenoid nitrogen. The extract might have been precipitated by phospho-tungstic acid, and the nitrogen determined in the filtrate.

"On the Derivatives of Ethylene Chloro-bromide," by J. W. JAMES. The author summarises his principal results as follows:—When preparing ethylene chloro-bromide by passing the gas into a solution of chloride of bromine (ClBr), it is necessary, to obtain a pure product and a good percentage, that the chlorine be passed into the bromide at 0°C ., otherwise a substance is formed boiling 3° or 4° higher than pure $\text{C}_2\text{H}_4\text{ClBr}$, which is useless for the advantageous preparation of ethylene chloro-thio-cyanate. If an aqueous solution of neutral sodium sulphite and ethylene chloro-thio-cyanate be brought together in direct sunlight, the sodium salt of a new acid, ethylene thio-cyano-sulphonic acid,—



is produced. By passing ammonia gas into an ethereal solution of chlor-ethyl-sulphonic chloride no amide is formed; with ethyl-sulphonic chloride, however, the corresponding amide is easily obtained. By the action of neutral sodium sulphite in aqueous solution upon ethylene di-bromide or chloro bromide, isethionate of sodium is produced with evolution of sulphurous anhydride, in addition to the well-known ethylene disulphonate of sodium obtained by Strecker.

After the thanks of the meeting had been given to the authors for their respective papers, the Society adjourned to November 16, when a ballot for the election of Fellows will be held, and the following paper was announced to be read: "Contributions to the Chemistry of Tartaric and Citric Acids," by the late B. J. Grosjean.

CORRESPONDENCE.

AN EXAMINATION QUESTION.

To the Editor of the Chemical News.

SIR,—The following question appears in the Chemistry Paper set at the Examination for the Licence of the Royal College of Physicians, 1st Part, October, 1882.

"4. 100 grms. of pure marble are treated with excess of hydrochloric acid. The gas evolved is dried and passed through a tube containing 100 grms. of pure lime. To what extent does the lime increase in weight?"

If this be given as a *catch* question it seems hardly fair thus to tempt the unwary candidate to his destruction; and if it be set in good faith, how can it be reconciled with the observation made long ago by Scheele that "anhydrous lime does not absorb carbonic acid, provided no water has access to it." (Gmelin's "Handbook," translated by Watts, iii., 185)?

A STUDENT OF CHEMISTRY.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Moniteur Scientifique, Queneville.
August, 1882.

Conclusions of a Report on the Metallurgy of Lead and Silver at Leadville, Colorado.—Antony Guyard.—From a Report on the Geology and Mining Industry, by S. F. Emmons, of the U.S. Geological Survey.

Determination of Zinc by Means of a New Reagent and its Separation from the Alkalies, Lime, Magnesia, Manganese, Copper, Nickel, and Cobalt.—Antony Guyard.—The reagent employed is crude ammonium sulpho-carbonate and is obtained by placing in contact for

some days, with frequent stirring, concentrated ammonia and carbon disulphide. When the mixture has acquired an intense yellowish red colour and a slight excess of carbon disulphide remains undissolved—when a drop of the liquid produces in an ammoniacal and slightly concentrated solution of a salt of nickel a precipitate which is purple by reflected and green by transmitted light—the reagent is ready for use. It must not be diluted with water, since the precipitate obtained is the more dense and granular as the solutions are more concentrated. A known weight of the zinc ore is dissolved in acids and treated with the ordinary mixture of sal-ammoniac, ammonia, and ammonium carbonate, to separate, iron, lead, lime, &c., and to the clear filtrate there is added a slight excess of crude ammonium sulpho-carbonate, until it appears of a decided reddish yellow. The zinc is precipitated as a very dense, granular, pale yellow deposit, absolutely insoluble in an excess of the reagent. The precipitation is performed at 66° to 80°, and the liquids must not under any circumstances be raised to a boil. The zinc sulpho-carbonate is collected on a double filter, and well washed with luke-warm water, and is then dried at 100° to 110°. At this temperature it is completely transformed into zinc sulphide, which, from its density, is not oxidised on contact with the air. The zinc may be either weighed in this form or it may be ignited in a current of sulphuretted hydrogen according to Carnot's process, or it may be transformed into oxide. The analytical value of this method depends on the fact that the zinc is entirely thrown down in a state which admits of easy collection and washing, and is at the same time completely separated from lime, magnesia, manganese, copper, nickel, and cobalt. Although this process is applicable in the analysis of bronze and brass, the author only recommends it for analysis of minerals containing an excess of zinc. Pure ammonium sulpho carbonate is of no use, since the presence of a certain quantity of ammonium sulphide is essential.

A New Antiseptic Compound and its Use in the Preservation of Alimentary Substances.—Prof. F. Barff.—From the *Journal of the Society of Arts*.

New Process for the Volumetric Determination of Zinc.—Antony Guyard.—When zinc and copper occur together in an ammoniacal solution, and we pour into this mixture a solution of potassium cyanide, this latter body only acts upon the copper when it has completed its action upon the ammoniuret of copper, so that the disappearance of the blue colour indicates the end of the reaction. If an unknown quantity of zinc contains a known weight of copper, or a known volume of a solution of copper, the strength of which has been previously determined by means of the solution of cyanide, then by subtracting the number of degrees of the burette necessary for the copper alone from the total number required for the mixture of zinc and copper. It is necessary to effect each determination under identical conditions of volume, temperature, concentration, and the nature and quantity of ammoniacal salts ought to be the same in the liquids.

New Process for the Volumetric Determination of Sulphuric Acid, Free or Combined.—A. Guyard.—The author prepares a normal solution of lead nitrate by dissolving an equivalent (in grammes) of this body in a litre of water. The solution containing sulphuric acid, sulphates, or a mixture of both, is placed in a burette graduated into tenths of a c.c. There are poured into a beaker, provided with a stirrer, 25 c.c. of the normal lead solution, and it is coloured a bright yellow by means of some drops of potassium iodide. We pour then gradually and stirring incessantly the sulphuric solution from the burette till the liquid in the beaker is completely decolourised. The number of divisions employed correspond exactly to the weight of sulphuric acid necessary to precipitate 25 c.c. of the normal solution of lead nitrate. This process is advantageous chiefly for determining the total acid. If it is desired to determine both

the free and the combined acid, the best process is the following:—Total acid is determined as above, and the free acid is then found by means of a standard ammoniacal solution of copper. The difference is the combined acid. These processes are recommended only when there is no other free acid except the sulphuric, and when the liquids in question contain mere traces of chlorides.

Preparation of Oxygen at the Common Temperature.—A. Guyard.—The author obtains oxygen in the cold by the action of concentrated nitric acid upon potassium permanganate. The gas is given off with great regularity, and if washed in a weak alkaline solution is absolutely pure.

Note on the Determination of Copper as Sub-sulphide.—A. Guyard.

Determination of Nickel as Sulphide.—A. Guyard.

Sulphurous Acid considered as a Reducing Agent.—A. Guyard.

New Process for Separating Ferric Oxide from Alumina and Titanic Acid.—A. Guyard.—These four last papers are taken from the *Scientific American*.

Fixation of Certain Artificial Colouring-Matters by Metallic Mordants.—H. Kœchlin.—This paper will be inserted at length.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Peroxide of Hydrogen.—Will any of your readers inform me or refer me to the best and cheapest way to manufacture this article on a large scale for use as generated in the liquid state?—R. D. B.

Mildew.—Will any of your readers refer me to the best authority on mildew, its cause and prevention, more especially in printed calicoes, as I can find no account of it in some of the leading chemical books?—H. C.

[“Sizing and Mildew in Cotton Goods,” by G. E. Davis, C. Dreyfus, and P. Holland. Manchester: Palmer and Howe. “The Sizing of Cotton Goods and the Causes and Prevention of Mildew,” by W. Thomson. Manchester: Heywood.]

MEETINGS FOR THE WEEK.

THURSDAY, 16th.—Chemical, 8. Ballot for the election of Fellows.
“Contributions to the Chemistry of Tartaric and Citric Acids,” by the late B. J. Grosjean. “Contributions from the Jodrell Laboratory, K-w. (1) Constitution of Lignin and Bastres, by C. F. Cross and E. J. Bevan; (2) Contributions to the Chemistry of Plant Fibre, by C. F. Cross, E. J. Bevan, and S. S. Webster; (3) Action of Nitric Acid on Cellulose, by C. F. Cross and E. J. Bevan.” “On the Constitution of some Bromine Derivatives of Naphthalene,” by R. Meldola.

TO SOAP-MAKERS.

Wanted, information as to Soap-making, from a practical Soap-maker, who is thoroughly acquainted with the trade in all its branches.—Address, “Soap,” CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

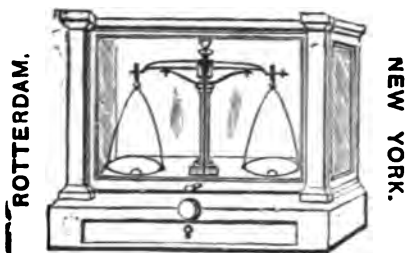
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SWANSEA.

THE CHEMICAL NEWS.

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TESTING FOR BARIUM OR SULPHURIC ACID.

By SPENCER PICKERING, B.A. (Oxon).

A DETERMINATION of the delicacy of the barium sulphate test gave the following results:—

The minimum strength of a solution of barium chloride in which the barium could be detected with certainty was found to be one containing 0.0000012 grm. of barium (=0.00000135 grm. BaO) per c.c., or 1 part of barium in 833,000 parts of water. As the cloudiness produced can easily be seen with 2 c.c. of the liquid it follows that the actual amount of barium which can thus be detected is 0.0000024 grm.; equal to 0.0000027 grm. BaO.

In the testing sulphuric acid was used; the reaction did not appear to be rendered more delicate by using alkaline ammonium sulphate; the reagents were left in contact for 5 or 10 minutes before the result was examined.

The best results are obtained by placing an artificial light almost vertically above the test-tube containing the liquid, and a black background behind, allowing the light to fall on a portion only of the liquid.

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS, late R.A.

(Continued from p. 200.)

III. ON A NEW BLOWPIPE REAGENT (concluded).

IV. Pyrological Analysis of *Acmite*.

(12.) SrSO_4 .—Applied a trace of powdered celestine to bead (11); great effervescence, after which all was dissolved to a colourless transparent bead.

(a.) Applied H.P. for some seconds; bead covered with flat discoidal crystals of an entirely different form from that of the previous ones; under a $\frac{1}{4}$ inch objective these were very small and extremely numerous, but all *precisely similar*, something like the rosettes on a horse's headstall.

(b.) With a more copious supply of celestine, and long H.P., much larger crystals than those of (a), solid, and in the interior of the bead appeared, but so aggregated that it was difficult to distinguish the form.

(13.) $\text{CaSO}_4 + 2\text{H}_2\text{O}$.—Two fragments of *selenite* to a fresh bead P.P. dissolved rapidly; not so much effervescence as (12) to a transparent colourless bead.

(a.) After H.P. large twin crystals or macles, polarising slightly, of a perfectly different form.

(b.) After strong O.P., and the bead allowed to cool (comparatively), in an "atmosphere" of ignited hydrogen (or in H.P.), fine, large, solid crystals in interior of bead; polarising well. In a $\frac{1}{4}$ inch objective, these fine crystals appeared in masses or groups, none separately formed, but all in macles, apparently belonging to the cubic system (*gypsum* crystallises in nature, in monoclinic or oblique forms).

(14.) MgCO_3 .—A trace of *magnesite* to a fresh bead, dissolved rapidly by O.P. with effervescence, to a transparent colourless bead.

(a.) The merest touch of H.P. rendered this bead nearly opaque, with minute star-like crystals, differing in form from all previously seen, but all precisely like each other.

(b.) After strong O.P., and bead cooled in H.P. a confused mass of flat or tabular crystallisation, with apparently many perfect circles (1) and curious combinations of angles and circles.

(c.) With more MgCO_3 and strong H.P., there was little or no effervescence (1) and no crystals; but, upon adding some more of this flux, H.P., the bead became quite blue, and some large and well-defined prismatic crystals appeared in the interior, with a large mass of indistinct crystallisation; transparent, but not polarising.

(15.) MnO_2 dissolved in a fresh bead, afforded in P.P. the usual amethystine bead; in O.P., reddish; in a weak H.P., reddish (1), and in H.P., colourless (shows that the flux retains oxygen).

(16.) BaCO_3 dissolved in a fresh bead in considerable quantity by O.P., without much effervescence, to a transparent colourless bead.

(a.) After a little H.P., large, flat, transparent crystals formed, polarising well. In a $\frac{1}{4}$ -inch objective, these appeared in symmetrical groups, something like a roughly-drawn butterfly; all similar.

(b.) With a greater supply of BaCO_3 in H.P., a mass of transparent crystallisation was formed, polarising well, but the forms quite indistinct.

(c.) When more of the flux was added to b, after some difficulty crystals were formed by H.P., chiefly separate, but with edges rounded and indistinct; apparently a kind of compromise between an angle and a circle.

Acmite.—"Pyr., &c., B.B. fuses at 2, to a lustrous black, magnetic globule, colouring the flame deep yellow, and with the fluxes reacts for iron, and sometimes manganese."—"Dana's Syst. Min.," page 224.

Acmite.—"Pyr., &c.—1. Powder in boric acid O.P. part dissolved to an opaque, dark brown bead, with complete yellowing of the green pyrochrome (probably an iron mineral with large proportion of soda); on addition of cobalt oxide O.P., cobalt borate dissolved, with a pink suffusion over the bead (over 10 per cent of alkali); on addition of lime powder O.P., no milkiness (no alumina). 2. Powder of a fused fragment, boiled and dried, in phosphoric acid* O.P.; about three-fifths unattacked sharp semi-transparent fragments (about three-fifths silica); about one-third black-brown opaque balls with rust-like matter (about one third iron); a few brown transparent balls, colourless after H.P. (a little manganese); one or two transparent balls; clear, hot; pale green, cold (trace of lime containing iron protoxide; no magnesia); one or two yellow fragments, blue after H.P., and producing a pale amethyst colour in a P. acid† glass, H.P. (trace of titanium). 3. Powder of (2) in pink P., acid O.P., about three-fifths undissolved (about three-fifths silica, consequently little or no alumina); bead remains pink (little or no alumina); with powder of (1) O.P. bead violetish blue (over 10 per cent of alkali).

Analysis by Berzelius of *Acmite* from Rundemyr.

SiO_2	..	..	..	..	..	55.25
Fe_2O_3	..	..	..	..	..	31.25
MnO_2	..	..	..	..	..	1.08
CaO	..	..	..	..	..	0.72
Na_2O	..	..	..	..	..	10.40
TiO_2	..	..	..	..	..	trace

98.70

(To be continued.)

* Made by dipping the red-hot boric acid bead for a second in deliquesced, pure phosphoric acid.

† "P. acid" = "glacial" phosphoric acid.

THE ABSORPTION OF METALLIC OXIDES
BY PLANTS.*

By FRANCIS C. PHILLIPS.

THE question how far the vital processes of plants are influenced by the various mineral compounds presented by the soil to their roots has long been under discussion in physiological botany, but further than to establish the fact that the presence of certain compounds in soil tends to increase the nutritious elements, and promote the growth of particular vegetables, little has been done towards a complete solution of the problem.

It is well known that potash tends to increase the quantity of starch, that silica strengthens the stems of the grasses, that oxide of iron is essential to the production of leaf-green, that phosphates increase the fertility of the soil for cereals, but even as regards these constant elements of every soil, very little can be positively asserted of the precise influence of any one, in the economy of the plant.

Concerning the part played by the rarer elements, cesium, rubidium, copper, nickel, manganese, zinc, and barium, in the assimilation of carbon, nitrogen, and the functions of nutrition, and whether they are beneficial or injurious, nothing whatever is known, although modern refinements in chemical methods have led to their frequent detection both in soil and in plants. That so important a problem should have remained almost wholly unsolved must be attributed chiefly to the very great difficulties which are met in any experimental investigation, but also to the fact that the few investigations published have been carried out, in most cases, for the purpose of proving that vegetation had been injured by metallic compounds traceable to a metallurgical works, and with the special purpose of founding a claim for damage, rather than to solve a scientific problem. The study of the influence of metallic compounds on plants has recently acquired great practical importance, from the fact that many manufacturing processes, more especially those employed in the smelting of lead and copper, and arsenical ores of various metals, have given rise to a gradual impregnation of the soil with such metals, and to the consequent poisoning of vegetation and animals.

In almost all cases where furnaces for the treatment of such ores have been erected, there has followed a serious injury to vegetation, caused by the metallic vapours and dust escaping from the flues; while the lawsuits instituted to recover damages have brought forward many interesting facts as to the extent of vapourisation of metals, the necessity and difficulties of providing proper means for condensing the noxious fumes, the evidence has seldom furnished any definite information as to the more general question at issue.

The possibility of injury to plants from such sources has been denied under an assumption that plants, like animals, possess a certain discriminating power, and that they are able to select and take up through their roots, such elements of the soil as are nutritious, and to reject all else, a view which is very commonly accepted, and has been held by high authorities.

With the very much less complete condensing apparatus in use in former times, the injury caused by such establishments was far greater than at present, but even at smelting works where the most improved machinery is in use, it is often difficult to prevent the escape of large quantities of poisonous mineral compounds, which in the shape of dust may be carried many hundred yards and scattered with injurious effects upon vegetation.

As early as the year 1668 mention is made of the injury to pastures, caused by lead fume, by Joseph Glanvil, who published a description in the *Philosophical Transactions* of the smelting of lead ores in the Mendip Hills.

This author says "there is a flight in the smoak, which, falling upon the grass, poysons those cattel that eat of it. They find the taste of it upon their lips to be sweet, when the smoak chancs to fly in their faces. Brought home and laid in their houses, it kills rats and mice."

"If this flight mix with the water in which the oar is washed, and be carried away into a streame, it hath poysoned such cattel as have drunk of it after a current of three miles."

Richard Watson, in his "Chemical Essays," published in 1799, calls attention to the saving to be effected, and the protection afforded to pastures, by the use of long horizontal chimneys, for the condensation of lead fume, in Derbyshire.

"But so difficult is it," says this author, "to wean artisans from their ancient ways that I question whether any of them would ever have adopted the plan they approved, if an horizontal chimney which was built in Middleton Dale to protect pastures from the smoke of the furnace had not given them full proof of the practicability of saving the sublimate of lead which is lost in the ordinary method of smelting."

Among more recent cases, the following, cited by Taylor, in his "Treatise on Poisons" (3rd American edition, p. 424), is of interest: "It was alleged on the part of the plaintiff that a large number of sheep and cattle had been destroyed by fumes of lead escaping from a chimney on the defendant's works. The case involved this curious point, namely: admitting the sheep and cattle to have been destroyed by lead, whether the lead was deposited on the herbage from the defendant's chimney, or taken up by the plants from the soil, and incorporated with their tissues. The condensing arrangements at the lead works were found to be almost absolutely complete, and there was not the slightest appearance of a deposit of white-lead on the herbage. But it was found that the herbage was impregnated with lead, and that seeds sown in the leaden soil, brought for this purpose to London, produced plants containing lead. The soil had derived the lead from ancient mineral workings."

Dr. Wilson (*Edinb. Monthly Journal of Medicine*, 1852), in a case somewhat similar to that cited by Taylor, of cattle poisoning by lead, found the herbage to contain the metal, and that beans grown upon a portion of the soil were impregnated in the same manner.

The results seem to point very clearly to the possibility of the absorption of lead by the roots of plants.

An exhaustive investigation into the action of copper and zinc on vegetation has been made by Dr. Freytag, of the Agricultural Laboratory in Bonn,* and the results published in an official report upon the injury alleged to have been caused by the smelting furnaces of Mansfield. In the neighbourhood of Mansfield, furnaces have been in operation for several centuries, and the soil in many places has in consequence become greatly deteriorated as regards its fertility, being charged with as much as 10 lbs. of oxide of copper and 24 lbs. oxide of zinc, to the ton of earth. In order to test the influence of these metals upon the nutritive qualities of the crops, Freytag made comparative analyses of clover and grass grown in the neighbourhood of the smelting furnaces, and of similar plants grown five miles distant, but under as nearly as possible the same conditions of temperature, moisture, and manuring. The plants from the neighbourhood of the furnaces differed in the following points from those grown at a distance.

1. They contained in their ashes varying quantities of the oxides of copper and zinc, as much as 0.2 per cent oxide of copper, and 0.36 per cent oxide of zinc.

2. There was a larger percentage of sulphuric acid,

* "Wissenschaftliches Gutachten über den Einfluss, welchen die Hüttenwerke der Mansfelder Kupferschieferbauenden Gewerkschaft auf die Vegetation und indirect auf Menschen und Thiere ausüben." Von Dr. Moritz Freytag. Eisleben, 1870.

* A Paper read before the Engineers' Society of Western Pennsylvania, Tuesday, February 21, 1882.

attributed by Freytag to the fact that the copper and zinc occur in the soil as sulphates.

3. The proportion of nitrogenous bodies was greater by 25 to 30 per cent (2 per cent of the dried plant). As regards the assimilation of nitrogen, therefore, the metallic sulphates were apparently beneficial.

Very interesting experiments have been made by Freytag upon the capacity of plants to absorb solutions of metallic salts.

Beans, peas, and other seeds were allowed to germinate in a solution containing nutritious matters, and after maturing, were transferred to solutions containing arsenious acid, the sulphates of iron, cobalt, nickel, zinc, and copper.

The result was that a solution containing 1-80th per cent arsenious acid proved fatal, as was also the case with 1-25th per cent sulphate of cobalt, 1-15th per cent sulphate of nickel, 1-50th per cent sulphate of zinc, 1-5th per cent sulphate of iron.

No injurious effects were produced by more dilute solutions, the plants continuing to thrive until the poisonous limit of concentration was reached, when they rapidly withered and died.

In all cases there were found in their tissues small quantities of the respective metals in whose solutions they had been grown.

Freytag says: "I have found that plants growing in solutions of metallic salts are killed when the concentration reaches a certain degree, which is in all cases below 1 per cent of the solution, and this statement applies equally to those salts which are essential to plant-life. If we accept this as equally true of plants growing upon soil, it follows that the moisture of the soil must contain very small traces of mineral salts in solution, and by experiment it has been shown that the watery extract of a soil which is charged with salts of the heavy metals always contains less than the fatal dose of such metals."

Freytag thus sums up:

"It has been fully demonstrated that plants are not capable of selecting from the substances presented to their roots, that they, are on the contrary, compelled to take up all matters alike, which are in a form fitted for absorption, but that matters insoluble in the moisture of the soil are never taken up in sufficient quantities to endanger the life of the plant."

Freytag claims as his own, the theory of non-discrimination of plants, but Liebig, in his "Agricultural Chemistry" (4th English edition, p. 66), states that "all substances in solution in a soil are absorbed by the roots of plants, exactly as a sponge imbibes a liquid, and all that it contains, without selection."

Freytag has detected zinc and copper in the leaves of oaks and birch trees in the Mansfield district, and in a series of experiments it was found that zinc added to soil in the form of carbonate is absorbed by rye, wheat, and maize, and is deposited in the leaves, stems, and seeds. Many plants growing near zinc mines absorb considerable quantities of oxide of zinc, and in two well-known cases new varieties are considered to have been produced by soil containing zinc, one a shepherd's purse (*Thlaspi alpestre*, variety *calaminaris*), the other a violet (*Viola tricolor*, variety *calaminaris*).

The latter plant is considered by some authorities to be a distinct species. The ash of the leaves of this violet contains 13 per cent oxide of zinc. Both of these plants are confined to localities where zinc is an element of the soil, and the zinc seems therefore to be an essential constituent.

Among the strongly poisonous metals, zinc appears, according to the investigations published, to be the most readily absorbed by plants. It is of singular interest, however, that experiments conducted in the botanical garden at Erlangen, have led to a negative result, as regards the possibility of its absorption, contradicting, therefore, those obtained by Freytag.

* Johnson, "How Crops Grow," p. 196.

In the report of the Commissioner of Agriculture (Washington, 1875), some experiments are described upon the action of Paris green on vegetation. Peas were sown in soil containing varying quantities of Paris green. No injurious effects were produced where the quantity of the arsenical compound was less than 900 lbs. per acre of soil. When present in larger quantity, the plants were feeble and were smaller in proportion as the arsenic was increased. With 1½ tons of Paris green to the acre the seeds failed to germinate. The plants were tested for arsenic, but were found to have not absorbed even traces of the metal recognisable by Marsh's test.

These results involve, therefore, a direct contradiction of Freytag's theories, both as regards the non-absorption of the metal, and as regards the vital processes of the plant. According to Heckel (*Comptes Rendus*, vol. lxxx., p. 1172), water containing 3-100ths per cent of arsenious acid prevents the germination of seeds and destroys the embryo plant.

For the purpose of throwing some light on this difficult problem of the influence of metallic oxides upon plant life, a series of experiments was carried out during last spring in the greenhouse of the Allegheny park, by the kind permission of the superintendent of the park, Mr. William Hamilton.

The object of these experiments was to determine, first, whether any injurious effects are produced upon plants by being grown in soil impregnated with certain metallic oxides; secondly, whether plants in a perfectly healthy state will absorb such oxides through their roots. In the early spring the greenhouse was filled with very young plants, in a vigorous condition of growth, which were being reared for the purpose of supplying the park in the summer. The plants selected were geraniums, coleas, ageratums, achyranthes, and pansies. This selection was made, not with reference to any special peculiarities of the plants, but for the reason that there were thousands of other plants of the same kind, and all equally advanced in growth, on the tables of the greenhouse, which afforded an opportunity for a close comparison of those grown upon poisoned soil with others grown under normal conditions.

The compounds used were the carbonates of zinc, copper, and lead, and as an arsenical compound, arsenate of lime. These compounds are almost absolutely insoluble in pure water.

The method of setting the plants was that commonly employed by gardeners in transplanting. Young plants, with their roots as nearly as possible intact, were placed in flower pots, and soil previously mixed with a weighed quantity of the metallic compound was poured in and pressed down around the roots. The first series included ageratums, which were grown in soil containing ¼ per cent white-lead.

The second series consisted of geraniums, which were grown in soil containing ¼ per cent carbonate of zinc.

The third series included achyranthes. The soil supplied to them contained ¼ per cent carbonate of copper.

The fourth series were coleas, which were grown in soil containing ¼ per cent arsenate of lime.

The fifth series included coleas, grown in soil containing ¼ per cent arsenate of lime.

The sixth series were pansies, grown in soil containing ¼ per cent carbonate of zinc.

All these plants enjoyed the usual careful greenhouse nursing, and as regards temperature, moisture, and fertility of the soil, the conditions were absolutely the same as in the case of the other plants, excepting the poisonous influence to which their roots were exposed.

The progress of each plant was watched and a record kept. On the 10th of June, eleven weeks after the commencement of the experiments, the plants were cut off above the roots, and those of each series subjected to analysis, with the following results:—

The ageratums, grown in leaden soil, matured and produced flowers as early as the most advanced of those

grown in ordinary soil. Their roots were very abundant and healthy, the only noticeable effect of the lead being that the leaves were of a yellowish hue. The analysis showed that lead had been absorbed in small quantities.

In the second series geraniums were reared in soil impregnated with carbonate of zinc. The plants were in every respect normal, bore flowers and produced abundant roots.

The analysis showed considerable quantities of zinc.

In the third series, achyranthes were grown in soil containing carbonate of copper. The effect of the copper was not visible in the plants at first, as they continued to grow rapidly, and were normal in colour. But in maturing, the bright leaves became darkened. It was found that the copper had killed the original roots, and totally arrested the development of new ones. The plants had apparently been nourished from the air alone. Very small quantities of copper were found in their ashes.

The most strongly marked results were produced in the case of the arsenic. In the fourth series, coles were grown in soil containing $\frac{1}{4}$ per cent of arsenate of lime. The effects of the poison were visible in a few days, the plants languishing and producing but few leaves. In the course of two weeks all were dead.

In the fifth series, coles were reared in soil containing $\frac{1}{4}$ per cent of arsenate of lime. The plants were feeble from the first, produced but few leaves, which were normal in colour. Although they endured with greatly diminished vitality, no increase in growth took place, and the stems were not strong enough to remain erect. In all cases the arsenic had totally destroyed the roots. Traces of arsenic were found in the analysis.

In the sixth series, pansies, grown in soil containing carbonate of zinc, produced abundance of roots and continued healthy. Analysis proved the presence of zinc in considerable quantities.

In view of conflicting statements of authorities, further experiments on a large scale, and extended to a wider range of plants, grown under varying conditions, would be needed to establish any general laws in regard to the absorption and influence of metallic poisons contained in soil upon vegetation. The discovery of these laws would probably lead to the discovery of methods for the prevention of such influences, so far as they are of a dangerous character.

From the experiments detailed above it seems safe to conclude, however:—

1. That healthy plants grown under favourable conditions may absorb through their roots small quantities of lead, zinc, copper, and arsenic.

2. That lead and zinc may enter the tissues in this way without causing any disturbance in the growth, nutrition, and functions of the plant.

3. That the compounds of copper and arsenic exert a distinctly poisonous influence, tending, when present in larger quantity, to check the formation of roots, and either killing the plant or so far reducing its vitality as to interfere with nutrition and growth.

In the case of the heavy metals, copper, zinc, arsenic, and lead, it seems to be probable that their oxides may under certain circumstances become deposited in the tissues of the plant. As to the manner in which this takes place, authorities differ.

It is supposed by Freytag and others, that plants absorb all soluble matters indiscriminately, through their numberless rootlets, that the absorption of poisonous metals causes no disturbance until a certain degree of concentration is reached, when the plant rapidly withers and dies; that plants are therefore spared the sufferings of chronic poisoning, but are very susceptible to acute poisoning, which is invariably fatal; while it is held by others that plants absorb only such elements as are essential and nutritious, refusing to take up what is poisonous or innutritious; metallic compounds found in the analyses are therefore to be traced to atmospheric deposit adhering externally.

The theory of Freytag seems to have the weight of facts in its favour, and if it is possible that crops may become charged in this way with poisonous elements of the soil, it becomes a matter of the highest importance that wherever there is danger of such impregnation the most efficient means be employed for its aversion; for soil once impregnated with copper, lead, and zinc, may year after year bear crops poisoned in the same manner.—*The Journal of the Franklin Institute.*

THE ORCHARD ALUM SPRING.*

By Dr. THRESH.

THIS spring, which appears to be a "descending" one, originates in a disused coal mine, near the summit of Axe Edge, the highest point in the Peak country. To get rid of this water a narrow tunnel has been bored through the side of the hill, just over the Staffordshire border, and about five miles from Buxton, and the water flows from the open end of this conduit into a tributary of the Dane. As the farm on the hillside is known as the Orchard (a most singular name for such a bleak and desolate spot), and the water has a strongly astringent taste, the spring is usually called the Orchard Alum Spring.

I am informed that years ago many members of the medical profession in the neighbouring towns and villages prescribed it frequently, but I do not think such is the case at the present time. The country people continue, however, to employ it, as a vermifuge, and as an external application for various skin diseases.

The water has a very decided red tint, varying in depth according to the character of the season. The sample analysed was collected after a period of continuous rain, and was not near so dark as it is usually seen, yet when placed in a wine-glass it looked like a pale sherry. Seen in large volumes in the deeper portions of the stream it has the colour of blood. It reddens litmus paper, but contains no free acid. When heated to about 150° F., it becomes quite opaque from the separation of a basic ferric sulphate, but if allowed to evaporate on the water-bath nearly to dryness, the basic salt re-dissolves and a yellow vitreous residue remains. When heated so as to cause the above salt to deposit, the supernatant fluid is quite colourless.

The mean of two concordant determinations of the specific gravity gave 1.00351 as compared with pure water at the same temperature, and each gallon was found to contain—

Fe ₂ SO ₄	..	..	..	..	174.426	grains.
Fe ₂ O ₃	..	..	..	..	6.275	"
Al ₂ SO ₄	..	..	..	..	72.908	"
MgSO ₄	..	..	..	..	21.055	"
CaSO ₄	..	..	..	..	14.381	"
FeSO ₄	..	..	..	..	1.596	"
Na ₂ SO ₄	..	..	..	..	0.537	"
K ₂ SO ₄	..	..	..	..	0.822	"
AlPO ₄	..	..	..	..	0.456	"
KCl	..	..	..	..	0.282	"
NH ₄ Cl	..	..	..	..	0.125	"
KNO ₃	..	..	..	..	0.170	"
SiO ₂	..	..	..	..	5.776	"

298.809 "

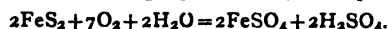
The results from which these quantities are calculated are tabulated at the end of the paper, and with regard thereto it may be remarked that in the first estimation of the phosphoric acid, the dried and weighed mixture of ferric and aluminic oxides and phosphates was fused with six times its weight of a mixture of 4 parts sodium car-

* Read at an Evening Meeting of the Pharmaceutical Society, Nov. 1.

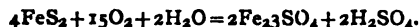
bonate and 1 of silicic acid. The mass was exhausted with water containing a little ammonia carbonate, traces of silica removed by evaporation with acid, and the phosphoric acid precipitated with magnesia mixture. In the second determination the mixed oxides, &c., were dissolved in nitric acid, and the phosphoric acid removed by aid of ammonium molybdate.

Reference to the composition of the water, as given above, shows that the medicinal properties of the spring are due to the ferric and aluminic sulphates of which it contains so large a quantity. Undoubtedly it is of too powerful a character for internal use unless very considerably diluted, but even then, as a tonic, its value is impaired by the presence of the sulphate of aluminium. Its acid reaction, of course, is due to the presence of these salts, and the excess of ferric oxide explains the decomposition which takes place when the water is heated. It is somewhat singular, however, that when carefully evaporated, the basic salt first deposited re-dissolves, yielding a residue which can be diluted, forming a very nearly colourless solution. The acidulous and basylous radials in this latter case can scarcely be in the same state of combination as in the original water.

We have not far to look for the source of the more abundant constituents. The spring arises, or rather issues, from the hillside immediately above the upper surface of the millstone grit formation, which is here exposed and forms the bed of the rivulet into which the water flows. Overlying the sandstone is a layer of aluminous shale of a blue-grey colour, and doubtless by the action of the air and water this suffers such decomposition as to produce the soluble salts found in the spring. The exposed edges of this shale are encrusted with ferric oxide, and here and there after rain the water dripping off is seen to be distinctly coloured. Usually water passing through such a stratum contains a considerable amount of ferrous sulphate together with aluminic sulphate and a smaller or larger proportion of ferric salts, the formation of the first named being represented by the equation—



The sulphuric acid then reacting upon the clay will form the aluminic sulphate. On the opposite side of the hill, the water flowing from a similar mine contains ferrous salt equivalent to 50 grains of crystallised ferrous sulphate to the gallon, with only a trace of ferric salt, and doubtless this is derived, by some such decomposition as the above equation represents, from the pyrites in the surrounding strata. To account for the formation of the ferric salt the oxidation must be carried further, the reaction being represented as follows:—



Further, by action of the ferric sulphate on the magnesium and calcium carbonates, with which doubtless the water comes in contact in some part of its course, the sulphates of magnesium and calcium would be formed together with ferric oxide and the basic ferric salt. An illustration of this decomposition is furnished by the stream into which the alum water flows. A few yards beyond the point where the iron water enters it, it receives another little tributary. The water in the latter appears to be rich in calcium carbonate, for where it falls into the larger stream the whole of the mixed waters become perfectly muddy, and for a considerable distance below the bed of the stream is thickly coated with an ochry deposit.

By way of conclusion it may be remarked that a water of this kind proves in a marked degree the futility of attempting to check the analytical results by comparison with the amount of solid residue left upon evaporation of a given quantity, whatever may be the temperature at which the residue is finally dried. The whole of the water could only be driven off in this case by heating to such a degree that the ferric sulphate began to decompose, and the residue then was so hygroscopic that an accurate weighing was impossible.

Table of amounts of products obtained during the analyses calculated as from 10,000 parts of water.*

	Portion of residue soluble in water.	Portion insoluble in water.	Total.	Total estimation.	Mean.
SiO ₂		0.825			0.825
BaSO ₄	67.188	2.334	69.522	69.406	69.464
AgCl	0.080			0.076	0.078
HNO ₃				0.015	0.015
CaO	0.449	0.391	0.840	0.853	0.846
Mg ₂ P ₂ O ₇ (for magnesia estimation)	2.742			2.822	2.782
NaCl				0.063	0.063
KCl				0.159	0.159
NH ₃				0.006	0.006
MN ₃ O ₄	Minute trace.				
FeO				0.108	0.108
Mg ₂ P ₂ O ₇ (phosphates)	0.093			0.088	0.090
Al ₂ O ₃ + PO ₄ + Fe ₂ O ₃	12.428	0.398	12.826	12.968	12.897
Fe ₂ O ₃				9.580	9.607
Al ₂ O ₃				3.204	3.213
Albumenoid NH ₃				0.001	0.001

Pharmaceutical Journal, November 4, 1882.

NOTES ON WATER ANALYSIS.†

By REUBEN HAINES.

WITHIN the past few years renewed efforts have been made to place the much troubled subject of water analysis in a more satisfactory condition. Among others may be mentioned the recent investigations under the direction of the National Board of Health of this country. Difficulties of an extraordinary character are experienced, inasmuch as the chemist is called upon not only to estimate quantitatively substances of the properties and constitution of which he knows little or nothing, and of the very existence of which he may be doubtful, but also he is expected to state his opinion as to their physiological effects when taken within the human body. In the latter demand may be said to lie in the majority of cases the exclusive interest of his client. People usually do not care much about the figures in the analysis; they simply want to know authoritatively, with certainty, whether the water is wholesome, and if not what is the cause and how it can be remedied. To answer these questions an exact quantitative analysis is considered necessary.

These difficulties are made a hundredfold greater by the fact apparently well established that some of these substances, whatever they may be, whether living or dead, can produce manifest effects when present in exceedingly minute quantity. Add to this the fact that, owing to different methods of analysis being used and different views being held as to the significance of the several results of analysis, the most diverse opinions have occasionally been expressed in regard to the wholesomeness of the water supply of a city or town by chemists of established reputation. Unfortunately some of these opinions have been expressed with a positiveness unwarranted by the state of our knowledge.

Surely any well-directed and well intentioned effort to relieve this important subject of some of its difficulties is commendable. Chemists are therefore to be congratulated, as being one of the steps toward this end, on the greater disposition to recognise the respective merits and demerits

* *Vide Journ. Chem. Soc.*, April, 1882.

† Read before the Chemical Section, Franklin Institute, Sept. 5, 1882.

of rival methods of research. The feeling is becoming more evident that no single method of analysis now used can with any probability tell the whole story, and also that chemical must of necessity be coupled with microscopical and biological studies in many sanitary water analyses. In other words, every ray of light gathered from all the various sources that can be thought likely to illuminate this confessedly obscure subject should be utilised in every important investigation. It is a matter of importance, therefore, that any method of analysis which is widely adopted should be worked in such a manner that it will give uniform and strictly comparable results in the hands of different but equally conscientious chemists. Any effort to elucidate causes of variation should therefore be welcomed, however trivial and unimportant they might at first appear. This must, therefore, be my apology in offering the present paper.

Wanklyn's ammonia method is very extensively used, but the descriptions of it and of the judgment to be placed on a given water, which are to be found in the five successive editions of his Manual of Water Analysis, are, on a number of points, in the opinion of some, by no means entirely satisfactory. Neither do the various scattered papers on this subject by other chemists agree very well among themselves or with Mr. Wanklyn's instructions. It thus appears evident that Mr. Wanklyn unfortunately has not described his method with sufficient detail on some important points so as to enable other chemists less experienced in water analyses to obtain strictly reliable results, or as nearly so as is attainable by his method. In its conception the method appears very simple and easy to follow, but the precautions found necessary by experience are numerous, and on these points Mr. Wanklyn allows his readers to rest too much on their own unaided judgment, or states his opinion in a brief, *ex-cathedra* manner not at all satisfactory to the thoughtful student when he finds an opposite opinion expressed by an equally accomplished chemist. This is particularly to be regretted where, unlike the analysis of a mineral ore or technical product, the judgment of the chemist based upon the analysis is of far greater importance than the analytical results themselves. In such cases the fullest explanations of the basis of the opinions expressed should be given by the author of the manual, especially in the later editions when the method is being extensively adopted. It is, therefore, a matter of regret that the last edition contains so little change from those preceding by way of suggestion, hint, or explanation, which ought reasonably to follow from more extensive use. It seems probable that to this deficiency may be traced many erroneous, and in some cases worthless, analyses that have been made, upon the results of which the question of sanitary improvements on a large scale were to be decided.

In view of all the points just considered, I offer the following description of the manner of working the method, not imagining, however, that it is the best that can be devised, but simply as one which I have found to give satisfactory results. I hope it may prove suggestive of improvements and may lead to a uniformity of practice. As compared with this the mere statement of results in a uniform manner is of comparatively insignificant importance, although also desirable.

For the details of the method, which are not included in this paper, I refer to Wanklyn's Manual.

ON THE ALBUMENOID AMMONIA METHOD.

In working the ammonia process of Wanklyn it is advantageous to connect the retort and condenser by means of a short piece of wide rubber tubing. The retort, selected of commercial pint size, but capable of holding more than 1 litre, should have a rather narrow neck, which can easily be thrust within the tube of the Liebig condenser to the distance of five or six inches without the glass surfaces being in actual contact. If the retort neck is rather too slender slip a second short piece of rubber tubing up the neck and thrust the latter into the condenser until the

two pieces of rubber overlap each other. The rubber should always be tied down with cord, both on the condenser and on the retort, because it expands and loosens its grip on the glass during the distillation. Before connecting them every part, including the rubber, is thoroughly washed with clean tap-water, and they are then put together.* The retort, if it is new, or if it has been used just previously for very bad waters, should in the first place be rinsed out with about 10 c.c. of concentrated sulphuric or hydrochloric acid. When the apparatus is once set up many analyses may often be made on successive days, or at longer intervals, without it becoming necessary to disconnect the parts. In this case, before pouring in the sample to be analysed, flush the whole apparatus with tap-water conveyed by rubber tubing to the tubulure of the retort, into which a short glass tube, bent at a sharp angle, is inserted so that the jet of water is thrown directly into the neck of the retort. Into the beak or smaller end, of the condenser a clean cork is inserted and the whole tube and retort neck filled with water. When the water begins to overflow into the body of the retort the cork plug is removed and the whole mass of water allowed to rush out. This flushing is repeated two or three times, and the outside of the beak of the condenser is also washed by pouring clean water over it. The water which has collected in the retort is removed by a glass syphon, which has been just previously well washed.† At the conclusion of an analysis the permanganate liquid is removed by the syphon, introducing clean water, and syphoning it out until no longer coloured.‡

In the case of very bad waters, however, a deposit of manganese oxide often forms on the bottom of the retort, which, if allowed to accumulate, may cause violent bumping, thereby endangering the retort and contaminating the distillates with permanganate. In such cases it is necessary to disconnect the apparatus and clean out the retort with a little hydrochloric acid, taking care to wash very thoroughly afterwards. The slight film of manganese oxide frequently forming high up on the sides of the retort may, however, be neglected as having no injurious influence. The prevention of this sudden bumping is sometimes a very troublesome matter. I find that it occasionally occurs with soft spring waters of first-class purity, and it cannot then be attributed to an accumulated deposit on the retort. A very pure spring water, which I have examined a number of times, has invariably bumped, often two or three times during a single distillation, with permanganate, and so badly as to foam up and flood the condenser without any warning or noise, even when the retort neck was inclined upward. It appeared rather to be owing to a sudden liberation of steam throughout the whole mass of liquid at once, but ignited fragments of pumice introduced into the retort did not check it. On the other hand, when an organic liquid, such as diluted milk, was introduced into the retort with this same spring water and permanganate, as in Wanklyn's method for estimating the albuminates in milk, the distillation, which before was very turbulent, now immediately became regular and tranquil, with no bumping, and small bubbles breaking on the surface instead of the large ones of the previous distillation to purify the water. On syphoning out the liquid after the operation was finished a considerable deposit of oxide, formed by the reduction of

* It may be proper to state that at the time of presenting this paper I had not read the articles on this subject which appeared during the early part of this year in the *Analyst*, in which a similar arrangement of the retort is recommended.

† It should be stated that the working details to be described may perhaps prove to be better adapted to the analysis of soft waters, or those waters the hardness of which is due to sulphates rather than carbonates. A number of the hard waters from the neighbourhood of Philadelphia, which I have analysed, are of this character. It is not likely, however, that calcium and magnesium carbonates would form any strongly adherent deposit on the bottom of the retort in a boiling liquid of comparatively high specific gravity, such as the permanganate liquid becomes. I have usually found that the deposited carbonates could be almost completely syphoned out by doing it while the liquid is still hot.

the permanganate, was found adhering to the bottom of the retort.

Several methods of avoiding this difficulty have been suggested in Wanklyn's Manual and in various papers in chemical journals. Some advise introducing into the retort recently ignited pieces of pumice or tobacco pipe, or else a judicious shaking or tapping of the retort during the distillation so as to produce a wavy motion in the liquid, or inclining the retort upward so that the liquid may not enter the condenser. I have tried all of these methods, but find the following plan decidedly preferable to any of them. I watch the retort very closely during the whole distillation when the trouble is likely to occur, and at the instant that the liquid is observed to foam up snatch away the Bunsen burner from below the retort, replacing it when the foam subsides. This may have to be repeated several times. In very troublesome cases it is well to keep the hand upon the burner ready to remove it instantly. Toward the latter end of the distillation spitting of the concentrating liquid is apt to occur. This may be checked by regulating the flame by a screw spring compressor on the rubber gas tubing and distilling more slowly. If a fourth or fifth portion of 50 c.c. has to be distilled over, the flame should be lowered to prevent the fracture of the retort, or else from 100 to 200 c.c. of perfectly pure distilled water should be added to the retort. The distillation should be continued until 50 c.c. of the distillate develops no colour with Nessler test on standing several minutes, or at least contains not more than 0.005 m.grm. NH_3 . This can be ascertained by Nesslerising the third or fourth 50 c.c. distillate while the following one is distilling. It is sometimes necessary to estimate the ammonia in the fifth or even in the sixth 50 c.c. portion, but usually the fourth portion contains less than 0.005 m.grm. NH_3 . Of course, the free ammonia must be known to be completely expelled before commencing the distillation with permanganate; hence, in highly ammoniacal waters it is best, after distilling off 200 c.c., to distill and Nesslerise a succeeding 50 c.c. before adding the permanganate to the retort.

In many cases the precautions above given against bumping will be found quite unnecessary, and other parts of the analysis, viz., the Nesslerising the free ammonia, and the estimation of the chlorine, may be attended to during the progress of the distillation. If the albumenoid ammonia distillates are Nesslerised in the reverse order, the third before the second and the second before the first, a tolerably accurate guess can be made at once as to the amounts of ammonia in each. In very many cases in my experience the first portion contains about twice the second and the second twice the third. We thus know at once whether it will be best to dilute the first distillate before adding the Nessler solution. Some waters, as for example those that are turbid with organic matter, or peaty waters, will not be likely to follow this rule, and some analysts have claimed that the manner in which the distillation progresses is a means of distinguishing vegetable from animal organic matter, or at least affords information which is an aid in forming a judgment of the quality of the water. It would seem best, therefore, to measure accurately each separate distillate and keep on permanent record the amount of ammonia which it contains.* If the water contains so much free ammonia as to give a decided colour with the Nessler test in 50 c.c. of the sample without distillation the free ammonia can be more accurately estimated by distilling off 200 c.c. in one portion, diluting with ammonia-free distilled water, taking out an aliquot part, and diluting again, if necessary, to 50 c.c.; Nesslerise this and multiply by the proper factor. Some of these ammoniacal waters appear to yield four-fifths, or even five-sixths, of the total amount of the free ammonia in the first 50 c.c. distilling over, instead of three-fourths,

which is usually the case as stated by Wanklyn. This variation is of no practical importance, however, since such a water would certainly be condemned by either method of calculation if it comes from a shallow well or spring.

In the distillation it is necessary to have a current of water through the condenser sufficiently rapid to avoid perceptible heating of the latter, except at the outlet. I prefer to use a 4-jet Bunsen burner, and operate on a half litre of the sample. I have obtained identical results when using quantities of half litre and full litre of the same water on the same day, or as nearly identical as is possible in these colorimetric estimations. My own limit of accuracy in colorimetric observation in matching the colours I have found to be 0.002 m.grm. of ammonia in amounts of more than 0.010 m.grm. in 50 c.c. of water. Hence, a plus or a minus error of this amount is liable to occur in every Nesslerising. I believe, however, that these errors, to some extent at least, neutralise each other, since several duplicate analyses can be made agreeing much more closely than would be the case if the errors were all in one direction. Moreover, the corresponding distillates in different duplicate analyses are often found to contain identical amounts of ammonia, which, of course, fortifies their accuracy, provided that the distillates are of equal volume. Although working on amounts of a full litre avoids the doubling of this error, there are counterbalancing disadvantages attending it. It is, of course, very necessary for the chemist to ascertain if he is afflicted in any degree with colour blindness. If he is colour blind only to a very insignificant extent, it may possibly be expressed quantitatively, and allowed for as a sort of "personal equation." But if this defect is very marked it is hardly necessary to say he ought to relinquish the practice of this method of water analysis, and perhaps all other methods necessitating colorimetric observation. This precaution is of some importance from the fact ascertained by statistics, that about one man in twenty is more or less colour-blind. Among women the percentage having this defect is much less. I find it is very difficult to estimate the colour when less than 0.005 m.grm. of ammonia is found in 50 c.c. of the distilled water; hence, amounts of less than this figure are neglected in adding up for the total amount. I do not think this error of omission can be avoided by distilling the albumenoid ammonia in one portion, returning this to the retort and re-distilling in separate portions of 50 c.c. each, as was suggested by Mr. Sidney Rich, for waters containing small amounts of albumenoid ammonia. Due allowance must, therefore, be made for these possible errors in the estimations of colours, when analyses of different samples of water are compared with each other, and a slight difference in results may indicate no real difference in the quality of the waters under examination.

It is important to have the alkaline permanganate solution guaranteed perfectly free from ammonia. This degree of purity I have been unable to obtain by following any of the directions for its preparation heretofore published. Dr. Tidy, in a paper on the methods of water analysis, read before the (London) Chemical Society, Dec. 5, 1878 (*Four. Chem. Soc.*, vol. 35, p. 62), states that he believes "it to be practically impossible to prepare alkaline solutions of potassic permanganate absolutely free from ammonia. I have, myself," he says, "followed with the greatest precision the details given by Mr. Wanklyn for its preparation, and, moreover, have tried a large number of other means that have suggested themselves, such as fusing the potash before dissolving, and such like, without avail. Nor have I found any permanganate solution made by others which was entirely free from ammonia. Hence it has always been necessary to estimate the quantity of ammonia in the permanganate solution, and to deduct this from the total amount obtained in the actual experiment."

In the discussion of this lengthy and important paper, which was postponed to take place at a special meeting on Feb. 6, 1879, Mr. Wanklyn, toward the close, stated that "he had never had any difficulty in obtaining his alkaline permanganate free from ammonia, and he could not tell

* The author of the paper in the *Analyst* cited above recommends mixing all the albumenoid distillates, measuring out an aliquot part, and making but one Nesslerising. It might be well to compare the numerical accuracy of the two methods.

what results might be arrived at by using impure solutions of permanganate, and allowing for the impurity" (CHEMICAL NEWS, Feb. 14, 1879). This remark was elicited by a question in regard to some extraordinary discrepancies in the analysis of certain London waters, by two chemists, both of whom used the ammonia method. Mr. Wanklyn, however, appears not to have explained how he obtained a pure solution of permanganate.

(To be continued).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 11th, 1882.

Prof. CLIFTON, President, in the Chair.

Prof. ROWLAND, of Baltimore, exhibited a number of his new concave gratings for giving a diffraction-spectrum. He explained the theory of their action. Gratings can be ruled on any surface if the lines are at a proper distance apart and of the proper form. The best surface, however, is a cylindrical or spherical one. The gratings are solid slabs of polished speculum metal ruled with lines equidistant by a special machine of Prof. Rowland's invention. An account of this machine will be published shortly. The number of lines per inch varied in the specimens shown from 5000 to 42,000, but higher numbers can be engraved by the cutting diamond. The author has designed an ingenious mechanical arrangement for keeping the photographic plates in focus. In this way photographs of great distinctness can be obtained. Prof. Rowland exhibited some 10 inches long, which showed the E line doubled, and the large B group very clearly. Lines are divided by this method which have never been divided before, and the work of photographing takes a mere fraction of the time formerly required. A photographic plate sensitive throughout its length is got by means of a mixture of eocene, iodised collodion, and bromised collodion. Prof. Rowland and Captain Abney, R.E., are at present engaged in preparing a new map of the whole spectrum with a focus of 18 feet.

In reply to Mr. HILGER, F.R.A.S., the author stated that if the metal is the true speculum metal used by Lord Rosse it would stand the effects of climate he thought; but if too much copper were put in, it might not.

In reply to Mr. WARREN DE LA RUE, Prof. ROWLAND said that 42,000 was the largest number of lines he had yet required to engrave on the metal.

Prof. GUTHRIE read a letter from Captain ABNEY, pointing out that Prof. Rowland's plates gave clearer spectra than any others; they were free from "ghosts," caused by periodicity in the ruling, and the speculum metal had no particular absorption.

Prof. DEWAR, F.R.S., observed that Prof. Liveing and he had been engaged for three years past in preparing a map of the ultra-violet spectrum which would soon be published. He considered the concave gratings to make a new departure in the subject, and that they would have greatly facilitated the preparation of his map.

Mr. W. BROWN then read a paper on the "Conservation of Energy and Central Forces." He showed that the doctrine of the conservation of energy necessarily involved central forces, and could not be proved unless on the assumption of a system of central forces. This involved the hypothesis of Bosovich that matter consists of a collection of centres of force, and the author criticised the objections of Clerk-Maxwell, Tait, and others, to Bosovich's theory. The paper will appear in the *Transactions* of the Society.

Prof. S. P. THOMPSON read some "Historical Notes on Physics," in which he showed that the voltaic arc between carbon points was produced by a Mr. Etienne Gaspar Robertson (whose name indicates a Scotch origin), at Paris, in 1802. This reference is found in the *Journal de Paris* for that year. Laboratory note-books at the Royal Institution, however, are said to show that Davy experimented with the arc quite as early. The experiment usually attributed to Franklin of exhausting air from a vessel of water "off the boil," and causing it to boil afresh, is found in Boyle's "new experiments touching the spring of the air."

Prof. THOMPSON also exhibited an early Reis's telephone made by Phillip Reis, in 1851, at Frankfort, and designed to transmit speech. It was modelled on the human ear, one form of transmitter being a rudely carved wooden ear with a tympan, having a platinum wire behind hard pressed against a platinum tipped adjustable spring. Prof. Thompson showed by various proofs that words were actually sent by that and similar apparatus.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, November 6, 1882

The Hon. SIR WM. R. GROVE, D.C.L., LL.D., F.R.S., Manager and Vice-President, in the Chair.

CAPTAIN W. de W. ABNEY, R.E., F.R.S., GEORGE WIGHTWICK RENDEL, M.I.C.E., were elected Members of the Royal Institution.

The special thanks of the Members were given to His Grace The Duke of Northumberland, for his valuable present of "Descriptive Catalogue of the Antiquities at Alnwick Castle, 1880;" and "Catalogue of Egyptian Antiquities at Alnwick Castle, 1880."

Two candidates for membership were proposed for election.

The Presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

NOTICES OF BOOKS.

The Magneto-electric and Dynamo-electric Machines, and the so-called Secondary Batteries, with particular reference to their Construction. (Die Magnetelektrischen und Dynamo-elektrischen Maschinen, und die sogenannten Secundär Batterien.) By GUSTAV GLASER DE CEW. A. Hartleben: Vienna, Pest, and Leipzig.

THE work before us forms the first volume of a series entitled "Elektrotechnische Bibliothek" (Electro-technical Library), which undertakes to treat in detail of the practical applications of electrical science. The author introduces his subject with a historical account of the gradual development of magneto-electric and dynamo-electric machines. He discusses in succession the phenomena of induction, the principle of the machine of Pixii, the commutator, Stoeher's magneto-electric machine, the cylinder inductor of Siemens, Pacinotti's ring, the current in a ring inductor, the direct action of the fixed poles upon the spirals of the ring, the construction of Pacinotti's machine, Wilde's machine, the principle of dynamo-electric machines, and Ladd's machine with two cylinders. In the first chapter we find an account of machines which yield alternating currents, such as the Alliance, those of de Méritens and Holmes, Weston's machine for galvanoplastic work, Mohring and Baur's dynamo-electric machine, the alternating machines of Gramme, of Siemens, and the Brush machine. The second chapter is devoted to machines producing currents in one direction only. Under this head we find especial mention of the

Gramme ring, collector, and light machine, the current in the spirals of tripolar magnets, the machines of Fein, Schuckert, Heinrich, Fitzgerald, &c.

In Chapter III. the author enters upon an examination of the merits and defects of the various kinds of electric machines. He considers that those which produce alternating currents are preferable for electric lighting on the systems of Jablochkoff, Jamin, &c., and they are always preferable when the object in view is not so much an advantageous utilisation of the power applied, but rather an equable consumption of the carbon points in the electric lamps, and an avoidance of residual magnetism in the electromagnets of these lamps. Hence these machines in their improved form—e.g., those of De Méritens—meet with a very wide application in lighthouses. On the other hand, if it is requisite to light up wide spaces, streets, or large halls, machines which produce continuous currents in one and the same direction are preferable. Such machines are likewise advantageous where it is desired to obtain the greatest possible effect from the machines, as they yield in the electric arc a result greater by about 35 per cent than do the alternating machines. They are also preferable for galvano-plastic and metallurgical purposes.

On comparing the magneto-electric and the dynamo-electric machines, the author pronounces the former more advantageous in their principles,—those especially whose inducing magnets are constituted by electromagnets.

As a formidable source of irregularities in the strength of the current of the dynamo-electric machines, we find reference to the changes which take place in the resistance of the exterior conduction. Thus, if the current is utilised for the production of electric light between two carbon points, every change in the luminous arc involves not merely an equal, but a proportionally increased, change in the strength of the current of the machine.

In the fourth chapter we have an account of arrangements for regulating the current, such as those of Siemens, Sawyer, and Maxim. Thence the author passes to the consideration of secondary batteries, such as those of Planté and Faure. The latter he considers will prove, under certain circumstances, of invaluable service, notwithstanding the loss of 40 per cent of electric power which they involve. Still their utility as portable accumulators is not so unlimited as it has been pronounced.

The fifth chapter is of a mathematical character. It deals with the physical laws which relate to the construction of electrical machines and their practical application.

In Chapter VI. the author gives special advice on the construction of the various parts of electric machines, such as the inducing magnets, the armatures, &c.

The seventh and eighth chapters discuss the application of the machines for the production of the electric light and for other purposes.

An appendix gives formulæ for the construction of electromagnets, and an account of the instruments useful for executing measurements in connection with electric machines. The work is provided with 54 illustrations, and with a table of the units employed in electrical measurements.

Arithmetical Chemistry, or Arithmetical Exercises for Chemical Students. By C. J. WOODWARD, B.Sc., Lecturer on Chemistry and Physics, Birmingham and Midland Institute. Part I., Elementary. London: Simpkin, Marshall, and Co. Birmingham: Cornish Brothers.

THIS little work proves—what the recent Presidential Address of Mr. J. A. Froude might lead the public to doubt—that the Birmingham and Midland Institute is still engaged in giving scientific instruction. Our readers will doubtless remember that Mr. Woodward some time back brought out a useful treatise under the title "Arithmetical Exercises for Chemical Students." The publication before us is a revised, or rather re-modelled, version

of that work. The author has added to the examples an explanation of the scientific basis upon which the problems depend. We have already expressed the opinion that exercises of the class in question—first suggested, if we mistake not, by Professor R. Galloway, of Dublin,—are of great value in impressing upon the mind of the student what may be called the mathematical phase of chemistry, and we certainly see no reason for modifying our opinion. We find here exercises in the metric system of weights and measures, in specific gravity, on the relations of the density of a gas to its molecular weight, in chemical equations, in the calculation of formulæ from centesimal composition, &c.

As an appendix we find "a collection of 100 problems, mainly taken from the examination papers of the Science and Art Department and the University of London Matriculation." To these are subjoined their answers.

On the fly-leaf we notice the announcement of another work by the same author. It consists, we find, of the whole of the questions in Physics and Chemistry, given at the Matriculation Examinations of the University of London, from June, 1864, to January, 1882. This work, the author considers, "must be useful to a large circle of teachers and students." Mr. Woodward is right; such a work will be of especial interest to those enterprising gentlemen who "prepare" students for examinations of all kinds. These teachers will subject the questions to a most careful analysis by this means, and by a minute study of the predilections and the idiosyncrasies of each examiner they will calculate with approximate accuracy for what questions the pupil must be carefully prepared, and what, on the other hand, he can afford to ignore.

The Yorkshire College, Leeds. Calendar for the Ninth Session, 1882-83, and Prospectus of the Leeds School of Medicine.

THIS publication gives a full account of the Yorkshire College, its history, constitution, day and evening classes, associateship, scholarships, examinations, &c. The Chair of Chemistry is still ably filled by Prof. T. E. Thorpe, F.R.S., who gives lectures in organic and inorganic chemistry, besides conducting a course of practical laboratory work. Professor Green, F.G.S., conducts the classes for geology, mineralogy, and mining. Experimental physics is taught by Professor Rücker, assisted by Mr. C. Spurge. We are glad to perceive that students of this subject have the opportunity of going through a complete course of laboratory practice.

The department for dyeing and tissue-printing, endowed by the Clothworker's Company of the City of London, is conducted by Mr. J. J. Hummel, F.C.S. The syllabus of instruction is exceedingly full, and embraces not merely dyeing in the stricter sense of the word, but the manufacture of tinctorial preparations, their adulterations, valuation, &c. There is opportunity for actual work in the dye-house from 9 a.m. to 5 p.m. every day during the session. Students in the dyeing department are expected, at some period of their College course, to present themselves for the Examination in Dyeing of the City and Guilds of London Technical Institute.

It may perhaps not be deemed ungracious if we note as a singular fact that although the Yorkshire College was originally intended to be for the study of Science only,—witness its pristine name, the "Yorkshire College of Science,"—the Principal of the Institution and Chairman of the Academic Board is the Professor of Classical Literature and Philosophy.

The Leeds School of Medicine, now beginning its 52nd Session, is to a certain extent connected with the Yorkshire College, where its students attend the lectures of Prof. Thorpe in Chemistry, and of Prof. Miall in Botany, Comparative Anatomy, and Zoology.

The value and the influence of the Yorkshire College are making themselves widely felt, and that not merely in a technological point of view. We have no doubt that as

the Institution gains strength, such men as Profs. Thorpe, Rücker, Miall, and Greene, will endeavour to lead their pupils into the path of original research.

Synopsis of Chemistry, Inorganic and Organic: To assist Students preparing for Examinations. By T. W. DRINKWATER, F.C.S. Edinburgh: Young J. Pentland. London: Hamilton, Adams, and Co.

MR. DRINKWATER begins his preface with the admission that "In these days of superabundance of chemical literature some apology is needed for introducing yet another chemical volume to public notice." It seems to us that some limitation is here needed. With good works on the philosophy of chemistry, and on many departments of chemical technology, we are by no means superabundantly provided. The excess is met with only in that very region which the author has selected, *i.e.*, in compendiums, manuals, synopses, handbooks, &c. The majority of these little works are compiled with the object, more or less distinctly expressed, of assisting students in preparing for examinations. Mr. Drinkwater tells us that certain portions of this book "have been for a considerable period (time?) in circulation among the members of my classes, and have proved of great assistance in preparing for examination my students, many of whom have not the time to collect and arrange scattered facts as presented in the Text-books." We call especial attention to the words we have italicised, as also to the following passage:—"It will, I hope, take the place of the Note-book in recalling the principal facts of the Science in the unsettled and troubled times which precede examination."

Having had the good fortune to grow up before the outbreak of the examination epidemic, we used to study with the humble and old-fashioned purpose of knowing. Consequently we cannot, from personal experience, judge of the wants of an intending examinee, and of what, in such "unsettled and troubled times," may prove most useful. But the above extracts border somewhat closely upon an avowal that the volume before us is written for "coaching" purposes. We hasten to add that by these comments we mean no disrespect to Mr. Drinkwater. He is the victim of a vicious system, and unless he conform to its dictates he must expect to suffer. The fault lies elsewhere.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 17, October 23, 1882.

Separation of Gallium.—Lecoq de Boisbaudran.—(See page p. 211.)

A Bed of Coal discovered in the Province of Algiers, and the Deposits of White Sand which Accompany it.—G. Pinard.—Coal has been discovered near Bon-Saada in Algeria. It is said to be equal in quality to the best French or English coals. The sand is of a quality fit for use in the glass manufacture.

Metallic Thorium.—L. F. Nilson.—The density of thorium as obtained by reducing the anhydrous chloride by means of sodium was found by Chydenius, 7.657 to 7.795. The author has obtained metallic thorium by heating sodium with the double anhydrous thorium potassium chloride, in presence of sodium chloride in an iron crucible. After treating the residue with water there remains a greyish, heavy, sparkling powder, which under the microscope appears to consist of very small crystals. Metallic thorium is brittle and almost infusible; the

powder takes a metallic lustre under pressure, is permanent in the air at temperatures up to 120°, takes fire below a red heat either in air or oxygen, and burns with a dazzling lustre, leaving a residue of perfectly white thorium. If heated with chlorine, bromine, iodine, and sulphur, it combines with them with ignition. It is not attacked by water, cold or hot. Dilute sulphuric acid occasions the disengagement of hydrogen, especially if heated, but the metal is acted on very slowly. Concentrated sulphuric acid with the aid of heat attacks the metal very slightly, evolving sulphurous anhydride. Nitric acid, strong or weak, has no sensible action. Fuming hydrochloric acid and aqua regia attack thorium readily, but the alkalis are without action. The metal examined by the author behaves with the reagents in question the same as did the specimens obtained by Berzelius. The mean specific gravity of pure thorium is about 11.000. Hence it would seem that the metal obtained by Chydenius must have contained much foreign matter. The specific gravity of pure thorium is 10.2207 to 10.2198. The equivalent and the density being known, we may calculate the atomic volume. If we admit that the metal is equivalent to 4 atoms of hydrogen, we obtain the value 21.1. This number coincides with the atomic volumes of zirconium (21.7), cerium (21.1), lanthanum (22.6), and didymium (21.5). This analogy is certainly not due to chance; it rather confirms the opinion which I have put forward in connection with my researches on the selenites, on certain chloro-platinates and chloro-platinites, &c., that the elements of the rare earths form a series of quadrivalent metals.

Determination of the Atomic Weight of Thorium.—L. F. Nilson.—The mean of six determinations gave for the equivalent of the metal 58.11, and consequently for its atomic weight 232.43. The mean of another series of four determinations gave: equivalent, 58.09; atomic weight 232.3 (oxygen is assumed = 8, and sulphur = 16).

Benzylene, Ortho-toluidine, and Methyl-phenanthridine.—A. Etard.—Not suitable for useful abstraction.

Reduction of Nitrates in Arable Soil.—MM. Dehérain and Maquenne.—The authors find experimentally that soil loses the property of reducing nitrates when it has been heated for some hours to 110° to 120°. Soil submitted to the influence of vapours of chloroform also loses its power of reducing nitrates. Soils, however, which have been thus sterilised by heat, recover their reducing power if mixed with a small quantity of normal earth. Hence the authors trace an analogy between the phenomena of the formation of nitrates and those of their reduction. The latter result is determined by anaerobic organisms.

Moniteur Scientifique, Quenneville.
August, 1882.

Industrial Society of Mulhouse.—Session of the Chemical Committee, June 14, 1882.—M. Camille Kœchlin made the following communication on aniline-black:—Aniline-black if developed at a temperature higher than 70° is ungreenable, whatever be the dehydrogenising metallic salt, if this substance and the duration of the high temperature are sufficient. All aniline-black formed in the cold is greenable. Ungreenable aniline-black was discovered in 1865 by M. H. Cordillot, of the firm of Huguenin Schwartz. The composition of Cordillot has the merit of being free from salts of copper. His black is produced by steaming aniline chlorate and ferricyanide. The important problem of transforming greenable aniline-black into the ungreenable state was solved in 1876 by M. P. Jeanmaire (Kœchlin Frères) who found that ferric salts possessed this property in heat. The various processes for converting a greenable into an ungreenable black all hitherto require a heat which dehydrates our mordants. M. Lauth, in a patent of 1869,

recommends to finish the dyeing by a hot passage in salts of chrome, copper, iron, mercury, alone or associated with chlorates, ferrocyanides, or chromates, but as this is only for the purpose of giving a tone to the black, and as the question of permanence is passed over in silence, these instructions do not affect the priority of Jeanmaire's process. A demonstration of the action of heat is easy by Lauth's process, dyeing with manganic oxide in solution of aniline. On operating in the cold the black is greenable; at 50° it retains this property; from 50° to 60° there is a change, and from 75° to 100° the black is ungreenable. This black is then less bluish, the difference being most appreciable in the greys. When dyeing on Lauth's system with conversion of the manganic mordant the solutions of aniline quickly blacken, and soil any colours which may exist on the manganese brown. This inconvenience may be remedied by adding to the aniline a twentieth part of naphthylamine and operating with very dilute solutions—2 to 4 grms. of alkaloid in the state of sulphate per litre, along with 20 grms. of calcined starch. These blacks, if produced in the cold and afterwards steamed, do not turn green sensibly. Lauth's process, which offers a commodious means of assaying the alkaloids, will remain the most rational, prompt, and economical, and is least injurious to the vegetable fibre.

Journal de Pharmacie et de Chimie.
Tome vi., September, 1882.

Influence of Gum Arabic in Certain Chemical Reactions.—MM. Jules Lefort and P. Thibault.—In dilute solutions gum hinders the precipitation of metallic sulphides. In concentrated solutions, or when the proportion of gum is small, there is precipitation more or less incomplete. The precipitation of the metallic oxides is also prevented whilst in presence of gum, quinine, cinchonine, morphine, strychnine, brucine, and veratrine are not precipitated by the usual reagents, ammonium phospho molybdate, potassium-mercury iodide, and tannin. The gum does not dissolve the various precipitates formed or prevent their formation, but merely holds them in suspension. These results have a certain physiological importance. Most inorganic fluids contain glutinous bodies, and it is hence possible to understand the simultaneous presence in a soluble state in the animal and vegetable cellules of compounds capable of acting chemically upon each other. In analytical operations gum and analogous bodies must be removed before certain determinations can be effected.

New Mono-chlorinised Camphor.—M. P. Caze-neuve.—Already noticed.

On a Point Relating to the Microscopic Examination of Urinary Sediments.—M. Yvan.—Sodium urate, when abundant, may mask uric acid, calcium oxalate, ferments, epithelial cells, &c. The author in such cases either dissolves away the sodium urate in water, when uric acid and calcium oxalate remain insoluble. Preferably he heats the deposit in a test-tube to 50° by means of the water-bath, and as soon as the sodium urate is dissolved throws the whole upon a small filter, whence the sediment may be transformed for examination.

General Survey of Electro-medical Apparatus.—Dr. Onimus.—A long and profusely illustrated paper not capable of useful abstraction.

Volumetric Determination of Potassa.—M. E. Burcker.—The author examines the two existing processes. In one of these the potassa is thrown down as cream of tartar by means of a solution of sodium bi-tartrate. The precipitate is then washed on the filter with a solution of potassium bi-tartrate saturated in the cold, in order to remove the excess of soda, then dissolved in hot water and determined alkalimetrically with normal soda. In the modification proposed by Marchand, after having prepared a standard solution of sodium bi-tartrate, each c.c. of which corresponds to 1 centigram. of potassa, the potassa

is precipitated by means of an excess of this solution, and the excess added is determined by means of a standard alkali. The author finds that the direct method is preferable, being not only more exact but more rapid. The presence of sodium and magnesium salts does not interfere, but calcium salts should be previously eliminated.

Mathematical and Experimental Researches on the Curves of Solubility in Water of the Varieties of Tartaric Acid.—M. E. Leidie.—The results of this investigation are given in the form of tables.

Detection and Determination of Lithia in the Waters of Vichy.—M. A. J. Mallay.—An abstract in which the methods used are omitted.

Distribution of Arsenic in the Organism in cases of Poisoning by Arsenical Compounds.—Prof. Ludwig.—Arsenic may be detected in the bones both in cases of acute and chronic poisoning. Contrary to the statement of Scolusuhoff the brain never contains more than a small proportion, whilst the liver and the kidneys contain a large proportion. The muscles contain little, but more than the brain.

Solubility of Potassium Bi-tartrate.—MM. Van Babo and C. Portele.—Water at 0° dissolves 0.37 per cent of bi-tartrate, and at 100° 6.102 per cent. The solubility increases gradually without any anomalies.

Physiological Action of Collidine.—MM. Marcus and Oechsner de Coninck.—Collidine paralyses the voluntary movements and acts upon the nerves of the cornea.

Poisonous Action of the Lupin.—M. Bellini.—This plant is frequently fatal to sheep, and exerts a similar deleterious action upon horses, goats, and dogs. The alkaloids present have not been sufficiently examined.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Manufacture of Pure Chemical Reagents.—Will any of your readers kindly inform me of the best text-books on the manufacture of pure chemical reagents for laboratory use?—A. C.

Hydrochloric Acid.—Will anyone afford information as to a cheap mode of tankage and transit (other than by carboys) of this fluid; and refer me to any notices of its industrial value?—J. H.

MEETINGS FOR THE WEEK.

MONDAY, 20th.—Medical, 8.30.

TUESDAY, 21st.—Institution of Civil Engineers, 8.
Pathological, 8.30.

WEDNESDAY, 22nd.—Society of Arts, 8. "Ice Making and Refrigeration," by Dr. John Hopkinson, F.R.S.

THURSDAY, 23rd.—Royal, 4.30.
Philosophical Club, 6.30.

FRIDAY, 24th.—Quekett Club, 8.

SATURDAY, 25th.—Physical, 3. "On Liquid Slabs," by Dr. F. Guthrie.
"On Rainbows formed by Reflected Light," by W. Ackroyd.

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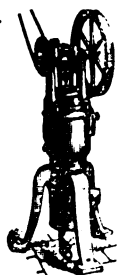
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THE CHEMICAL NEWS.

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ON

25 NOV. 82

NEW METHOD OF MAKING A VOLUMETRIC SOLUTION FOR DETERMINING THE HARDNESS OF WATER.

By C. R. C. TICHBORNE, LL.D., F.R.C.S.,
Analyst to County Longford, &c.

It is rather curious to observe that in spite of our constant familiarity with the determination of the hardness in waters, we have never been able to improve, or modify, to any extent the original process of Dr. Clarke, invented nearly half a century ago. We may go even further, and state that we have never been able to throw doubt upon his original investigations, and that they stand as he left them. Any so-called modifications are merely nominal, and have been made to suit the modern centesimal mode of expression. The most important proposals have been made in connection with the making of the soap solution and the standard calcium solution used for titration. A few of these modifications are, without doubt, improvements; but none of them touch in the slightest degree the principle of the process. Thus, in making the soap solution, Dr. Clarke used a soap made from animal fats (curd soap), and it has been respectively proposed to use a soft soap made from olive oil, lead soap (*emp. plumbi*), or a soda soap of olive oil (Castile soap). All these last proposals are undoubtedly better than the original curd soap, as proposed by Dr. Clarke, owing to the very simple fact that the fatty acids in the last three mainly consist of oleic acid, and that the oleates are less prone to separate in cold weather than the corresponding fatty bodies found in the curd soap.

As regards standard hard waters, I had adopted for some time the well-known modification of dissolving an equivalent quantity of powdered selenite. This process leaves nothing to be desired as regards the construction of a calcium solution. It is simple and gives most accurate results, providing there are no crystals of celestine in the selenite,—an experienced geologist will instantly detect them by his eye. It will be seen, however, further on, that the author proposes to dispense with the use of the calcium solution.

Having premised thus far, it might be asked, Why seek to change, or improve upon the process? Experience shows that the most troublesome part of the method consists in making the soap solution. Soaps are too indefinite in composition to admit of making a reliable solution by merely weighing out a given quantity and dissolving it in a proper quantity of spirit. Assuming that a soap of a definite fatty acid could be always obtained, we find the amount of water to differ so considerably as to render a titration necessary; a titration, too, which presents some considerable trouble.

My first idea was that if we took oleic acid and neutralised it with a standard solution of sodium hydrate, the latter base would represent the calcium salts, constituting hardness, equivalent for equivalent. I found, however, in practice that this is not quite so simple a matter as it would appear at first sight, but at the same time it is quite easy to construct a soap solution upon the basis of the soda hydrate consumed by the fatty acid.

The quantivalence of oleic acid may be, and has been, variously viewed. It is generally viewed as a mono-basic acid. As acid salts, however, are known, it may with equal propriety be classed as a bibasic acid; whilst, as will be seen further on, there is every reason to think that tetra-basic compounds of the alkalis exist.

5 c.c. of commercial oleic acid were dissolved in 50 c.c. of spirit of wine, and 1 drop of a 0.5 per cent solution of phenol-phthalein added. A volumetric solution of soda was then run in until a pink indication was obtained. After repeating this experiment two or three times the reaction was found to be not only well defined, but very constant. If litmus were used, not only is it difficult to determine the point of saturation, owing to the gradual transition of colours, but owing to the permanent dissociation of a trace of the oleates when in solution (to which the litmus is amenable), the reagent is not suitable to the experiments detailed. The 5 c.c. of oleic acid exactly worked off at 15.5 of the normal solution of soda of the British Pharmacopœia, which represents 0.62 grm., of sodium hydrate. Theory for the oleate having the formula $M'C_{18}H_{33}O_2$ would require 0.6 of hydrate of sodium, assuming the 5 c.c. of acid weigh 4.575 grms. Most samples of oleic acid found in commerce have a slightly lower gravity than this.

At this stage of the experiments a curious observation was made when water was substituted for the alcohol. The 15.5 of volumetric solution when added, as I have previously stated, gave a permanent liquid product of a faint pink tinge, showing that the point of neutrality had just been passed. A drop more of the volumetric solution developed a magenta colour, which was permanent as long as the solution was left at this point of saturation. A further equivalent of sodium hydrate was then run in (*viz.*, 15.5 c.c.), when it gradually became colourless again, and at 7.75 c.c. began to peñise; the solution at this stage represented about the consistency of thick mucilage. When the full equivalent was present the solution became a solid jelly. The vessel in which it was obtained might be inverted with impunity. The peñised oleates seem to be permanent and definite compounds. From their behaviour when thrown into alcohol they appear to be hydrated compounds and are perfect colloids. If we push the action further, other compounds are formed which are much more soluble. There seems to be a wonderful analogy between silicic and oleic acid, and the technical application of silicates in soap making appears to have been one of those chance discoveries which are in advance of scientific knowledge. As I intend to reserve this part of the subject for a separate communication, I have only to consider on the present occasion the practical bearings of these observations.

The measures of the hardness in water are really the fatty acids, and it is almost immaterial whether we use the mono-basic or di-basic salt above mentioned. In these remarks we retain the old formula of oleic acid, but it is evident that the whole subject requires revision. We find by experiment that very little difference will be obtained, but that as the peñised salt seems to lather more freely, and as the solution seems more permanent, I prefer it.* We, however, always depend upon the sharp reaction obtained on adding the soda until the pink solution is developed with phenol-phthalein. This point always represents the proportion of NaHO as equalling pure $C_{18}H_{34}O_2$.

The following is the process:—

As already mentioned, 5 c.c. of oleic acid are measured with a pipette and 50 c.c. spirit added to it in a beaker; 2 drops of phenol-phthalein solution are also added, and immediately a volumetric solution of soda—

$$\left(\frac{\text{NaHO}}{1000} - \right)$$

is run in until a pink indication is produced. This must be done accurately, as the success of the process depends upon this measurement. If the gelatinous salt is required, another quantity of soda is then run in. The oleate of soda is then made up to the required measure by the

* This remark is not strictly true. I have found specimens of some oleic acids which do not work well, and do not readily peñise, and wherever there is any doubt about the results it is safer to merely add the exact proportion to neutralise the acid, as indicated.

addition of a mixture of equal parts of rectified spirit and distilled water. Each 15.5 c.c. of soda used in the first saturation equals 820 c.c. of volumetric solution of soap. Thus—

$$\frac{x \times 820}{15.5} = x$$

x being the number of c.c. of soda solution which the oleic acid works off at, it is to be made up x . Such a solution makes a lather exactly on the original scale of Clarke, and it becomes unnecessary to titrate such a solution against a calcium solution, the soda solution being quite as definite and reliable as a calcium solution. Again, although different oleic acids might differ in purity, such a condition of things introduces no error; as the volumetric soap solution is made up on the saturating power of the acid employed, this alone determines the strength. Oleic acid obtained from the candle manufacturers, and a pure sample from Messrs. Hopkin and Williams, gave me exactly the same results in this respect, although they differed very much in their pecking properties. The 15.5 c.c. of soda required to saturate 5 c.c. of acid always neutralised in my experiments; but I am not prepared to say that this would be generally the case, and it is difficult to make in different hands a pipette always delivering separately the same amount of an oily fluid like oleic acid, therefore I proceed on the above basis of calculation.

The above process gives a solution, 32 c.c. of which when operating on 100 c.c. of water represent 16° of hardness per gallon by Clarke's scale.

The advantages claimed are that the soap solution may be made in five minutes,—requires no titration against a standard water,—and is more permanent than those made from ordinary soaps.

ESTIMATION OF SULPHUR IN PIG-IRON.

By H. ROCHOLL.

IN the description of his new process for estimating sulphur in iron and steel by means of hydrogen peroxide (CHEMICAL NEWS, vol. xlv., p. 199), Mr. G. Craig incidentally states, and apparently proves by experiments, that the residue left on dissolving pig-iron in strong hydrochloric acid be free from S, even should the metal under trial contain considerable quantities of copper. As according to this statement—generally and particularly in reference to the latter class of pig-iron—the information of the best analytical handbooks and the results of several previous contributors to this journal are incorrect, and certain troublesome precautions, or corrections, of analysts seem unnecessary, I think it ought not to pass without criticism.

Mr. Craig's proofs would indeed be surprising to those who have paid some attention to this subject, had he not duly given his method of examining the residue, viz., oxidation with KClO_3 , evaporation to dryness, filtering, and mixing the filtrate with BaCl_2 solution. The presence of such large quantities of KCl and Fe_2Cl_3 would certainly prevent the precipitation of the small quantity of sulphur present, as even is proved by the author's intended check-experiment for the cupriferosus pig. Here he obtains—in accordance with general experience—less sulphur when oxidising the whole of the metal with KClO_3 and HCl than what is evolved, on solution in HCl , in the gaseous form alone.

I would not, in the presence of ample evidence in respect of ordinary pig-iron, deem it necessary to give further data which disagree with Mr. Craig's conclusion, as, indeed, the difference in this case is insignificant, had not found, on referring to some former experiments in his direction, some results which I think are worth recording: in some cases I obtained more than half of the

S contained in cupriferosus iron from the residue. The samples (10 grms. each) were in the usual way dissolved in HCl (50 c.c.), the hydrogen being passed through a five-bulb tube containing a solution of AgNO_3 in weak ammonia. The Ag_2S was separated and oxidised by Br water, the mixture filtered, and the filtrate precipitated by BaCl_2 , when a portion of the sulphur (A) was obtained. The residue in the flask was likewise filtered, the solid portion (SiO_2, C , &c.) washed into a basin, evaporated, and then successively treated with HNO_3 and HCl , dried, re-dissolved, and filtered. From this filtrate in all cases a second precipitate was obtained by addition of BaCl_2 , representing a second portion of sulphur (B). Finally the filtrate from the carbonaceous residue was diluted and mixed with BaCl_2 solution, when in no case, after several days standing, was a precipitate obtained.

Copper.	Total Sulphur. P.c. of Pig.	Sulphur A evolved as H_2S . P.c. of Pig.	Sulphur B contained in Carbonaceous Residue. P.c. of Pig.	Sulphur P.c. total P.c. of Pig.
1. Cleveland pig-iron— none	0.075	0.069	0.006	8
2. Ordinary Bessemer pig— 0.02 (about)	0.045	0.041	0.004	9
3. Ditto 0.02 (about)	0.026	0.021	0.005	19
4. Cupriferosus ditto— 0.20	0.065	0.050	0.015	23
5. Ditto 0.23	0.017	0.011	0.006	35
6. Ditto 0.26	0.061	0.029	0.032	52
7. Ditto 0.26	0.064	0.027	0.037	58
8. Ditto 0.26	0.026	0.009	0.017	65
9. Ditto 0.27	0.041	0.026	0.015	36
10. Ditto 1.09	0.071	0.046	0.025	35

The first three analyses, representing ordinary pig-iron, are only a few of many others giving similar results, sulphur B varying from 0.004 to 0.007 per cent: I think an allowance of 0.004 per cent might fairly be made as an addition to the S, obtained by whatever method from the gaseous current. For cupriferosus iron, however, a separate treatment of the residue is indispensable; the quantity of sulphur contained in it seems to depend as well on the total percentage of this element as on the quantity of copper present.

Clarence Iron Works, Nov. 13, 1882.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON, FOR THE MONTH ENDING OCTOBER 31ST, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

November 1st, 1882.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the month of October, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily from O $\bar{c}$. 1st to O $\bar{c}$. 31st inclusive. The purity of the water in respect of

organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, one was "slightly turbid," and six were recorded as "very slightly turbid." The remainder were well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, one was "slightly turbid" and five "very slightly turbid." The remainder were well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

During the latter part of the month, the condition of some of the samples of water examined was unsatisfactory in respect to their colour, turbidity, and proportion of organic matter. Having regard, however, to the exceptionally flooded state of the river, and its occurrence at a period of exceptionally high tides, the condition of the water supply as a whole, though comparing disadvantageously with that prevailing during the summer and early autumn, is scarcely open to unfavourable comment. Thus, putting aside the New River Company's water, as being largely contributed to by wells, and confining attention to the case of the East London Company, drawing its supply from the Thames and the Lea, and to the case of the Chelsea, West Middlesex, and Grand Junction Companies, drawing their supply from the Thames—in one sample only out of fifteen was the proportion of organic matter at all excessive, in seven samples only out of 104 was there any tinge of colour noticeable on careful inspection of the water in a tumbler or decanter, while in not one sample out of the 104 was there found any recognisable turbidity or freedom from brightness. Out of the total 182 samples of water examined, two only were recorded as "slightly turbid," and eleven as "very slightly turbid." In fourteen of the 182 samples, a slight but distinct brownish colour was perceptible, which—being in excess of the faint tints either not appreciable or scarcely appreciable on mere inspection, which alone come within the limits of measurement by the colour-meter—is in these instances left unrecorded numerically in Table II.

We have the honour to remain, Sir,
Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

Chemical and Physiological Researches on Certain Animal Fluids.—J. Moursion and F. Schlagdenhauffen. —The liquids examined were those of sea-urchins, of hydatid cysts, and of Cysticerci, and the amniotic fluid. In each case the presence of a ptomaine was detected.—*Comptes Rendus*.

NOTES ON WATER ANALYSIS.*

By REUBEN HAINES.

(Concluded from p. 230).

I HAVE found it possible to prepare the permanganate solution so pure that when a litre of it is distilled *by itself in an undiluted condition* it will yield in the first 50 c.c. distillate, not more than 0.005 m.grm. of ammonia. To obtain it in this condition, I dissolve the required amounts of caustic potash (white sticks), and of permanganate in separate portions of ordinary distilled water; then mix, and dilute further to about 1500 c.c., and boil down rapidly in a capacious flask over a Bunsen burner to about 500 c.c.; then dilute again to about 1200 c.c. with ordinary distilled water, and boil again, as before, to about 900 c.c.; when cool make up the litre mark with water which has been re-distilled with alkaline permanganate till free from all traces of ammonia and organic matter. I have secured the same result by diluting in the first place to more than 2 litres with ordinary distilled water, and rapidly boiling down to about 900 c.c. and then at once making up when cool to the litre mark in the manner described. If I used ordinary Schuylkill river water for making the solution I found it was practically impossible to get it free from ammonia, nearly equal amounts continually coming over in the protracted distillation. In laboratories where the water supply is limited the flask need not be connected with the Liebig condenser until the boiling is nearly completed. This attachment is conveniently made by means of a large glass tube, bent at a right angle, and fitted to the flask and to the condenser by two pieces of wide rubber tubing, in such manner that it is only very slightly exposed to the action of the steam. It is scarcely necessary to add that it should be very thoroughly washed just before being attached. If, on testing the distillate, more than 0.005 m.grm. of ammonia is found the solution in the flask must be boiled longer or distilled water added and boiled down again as before. Care should be taken not to concentrate the solution too far, as it may thus suffer decomposition, and pass over into the green manganate with evolution of oxygen. This accident occurred twice with the present writer. This fact was also noticed by Mr. Wanklyn, as stated in the *Philosophical Magazine* for Feb., 1879. He says that "at temperatures very little above 100° C. a mixture of pure K_2MnO_4 and KHO evolves oxygen gas." In the concentrated liquid the boiling-point rises, of course, in proportion to the degree of concentration. "The gas is evolved very freely at temperatures even below 140° C., and the numerical results accord very well with the equation $2(KMnO_4) + 2(KHO) = 2(K_2MnO_4) + H_2O + O$. Hence the permanganate loses one-fifth of its active oxygen and becomes manganate of potash." I have also found that if the requisite quantities of permanganate and of caustic potash are dissolved in separate portions of water of somewhat more than one-half litre each, and a part of the permanganate is then poured into the potash solution while quite warm, the permanganate is in a few minutes completely reduced to the green manganate. It seems, therefore, that the mixing should always be done in the reverse manner and when the solutions are cold; that is to say, the potash solution sufficiently diluted should be gradually added to a dilute solution of permanganate.

In boiling the mixed solutions the appearance of numerous small bubbles over the surface of the concentrated liquor will be found to indicate that the solution is losing oxygen.

With the solution made in the manner described I have found some shallow wells so pure as to yield only 0.026 m.grm. per litre (or parts per million) total albumenoid ammonia, without correction, and including in the calculation the 0.005 yielded by the last distillate which gave

* Read before the Chemical Section, Franklin Institute, Sept. 5, 1882.

the slightest colour by the Nessler solution. Obviously no correction was admissible in such cases.

I believe, with Mr. Wanklyn, that it is unsafe to use an impure solution of permanganate, and make a correction for that impurity. Some time ago when using a solution of much less purity than the one described, I found several instances where, in distilling off the albumenoid ammonia from spring waters of the very purest character, the total amount of this ammonia obtained was less than the amount of correction which was to have been made for the ammonia in the 50 c.c. of permanganate used in the analysis. In other words part of the ammonia had disappeared or was not developed in the diluted permanganate in the retort.

The Nessler solution I have found to be more satisfactorily prepared according to the directions of Dr. Frankland than according to those of Mr. Wanklyn. Particular care should be taken to render it sufficiently sensitive by a little addition of mercuric chloride solution. In Nesslerising 50 c.c. containing 0.040 m.grm. ammonia, the full colour ought to be developed almost immediately, and no change in intensity ought to be perceptible after half a minute has elapsed. In solutions containing less ammonia the colour is developed more slowly, but with even so little as 0.005 m.grm. the colour ought to be fully developed in less than two minutes. The whole estimation should be concluded as soon as possible for several reasons, one of which is that occasionally a turbidity will occur in the Nesslerised distillates in about ten or fifteen minutes, or a bright red precipitate will sometimes be found at the bottom of the glass when exposed to bright light, both of which occurrences are altogether fatal to any accuracy. The rapidity of development of the full colour produced by the Nessler solution is believed to be wholly dependent upon the degree of sensitiveness imparted by additional mercuric chloride to the Nessler solution. My experience in the rate of this development differs from the author of the articles in the *Analyst* cited near the beginning of this paper, and leads me to suppose that his solution was not made as sensible as may be possible.

The storage bottles of the Nessler solution should be kept as full as possible, the stoppers of which may be coated with paraffin, and a smaller bottle should be kept for immediate use. For this purpose I prefer to use a 2 oz. wide-mouthed, glass-stoppered bottle, the stopper of which has never become tight, although it is not paraffined, which is, I think, an advantage in a bottle which is so constantly opened. This stopper is always replaced immediately after taking out the 2 c.c. by the pipette for each Nesslerising, as the solution should be exposed as little as possible to the atmosphere of the laboratory. By using the volume pipette with proper care the flocculent sediment which gradually forms at the bottom of the bottle produces little or no inconvenience to the operator, and only a very little of the solution need be thrown away at the last. The pipette for the Nessler solution serves also as a stirrer, and should always be washed immediately before and after each Nesslerising. This can be conveniently done by plunging the stirrer each time into a larger and firmly standing cylinder containing water which is fairly free from ammonia. If river water does not give the faintest colour with the Nessler test when not distilled it is sufficiently pure for this purpose. This water must of course be changed after a few testings. To make sure that everything is going on right it is well to have a blank Nesslerising cylinder handy containing water free from ammonia. By experience one can guess quite closely at the amount of ammonia present immediately after dropping in the Nessler solution, and it is not necessary to wait for the full development of the colour before making up the comparison cylinder. Hence, all the distillates and comparison cylinders can be Nesslerised in rapid succession. Since it is only occasionally that the experienced analyst finds it necessary to make up anew a second comparison cylinder of a different strength, the whole series of Nessler tests can often be completed

within a very few minutes if all the apparatus required is ready for use at his elbow.

I have dwelt particularly on this point because some chemists appear to have been dissatisfied with the slowness and tediousness they have experienced in this operation, and on this account have been led to devise various methods and appliances for shortening it. Thus, some have used comparison tubes containing standard caramel solutions, either simple or those brought to the proper tint by the addition of colours like aniline red, &c. Otto Hehner devised a cylinder, graduated on the side and with a glass tap at the base, and estimated the amount of ammonia by the height of the column of liquid when the tints were equalised. Prof. A. R. Leeds has devised an expensive apparatus carrying two glass reflectors, between which the Nesslerised cylinders are placed, and the colours estimated in comparison with light passing through a prism containing a solution of caramel and aniline red. Although I have never used Leeds's apparatus, I think I can endorse the opinion I have seen somewhere expressed by an English chemist that all of these supposed aids will prove only to be hindrances to the experienced worker, and their proper management consumes more time than the original unaided method. It has some years ago also been shown that it is frequently impossible to secure the proper tint by caramel solution, and a mixture of caramel with such colours as aniline will be apt to change in a short time on exposure to light. I have tried the simple caramel solution, and as it has been the experience of other chemists, I have been compelled to abandon it. I have no doubt, however, that for such colorimetric estimations as Eggertz's method for carbon in steel Leeds's apparatus will prove a useful aid.

In regard to the time consumed in Nesslerising it will be understood that the purer the water under examination the more rapid are the testings; for with impure waters the distillates must be measured, diluted, and an aliquot part taken for the Nesslerising, which latter may have to be repeated several times before a convenient colour is produced. It is best not to have the colour too deep, nor should it be very faint. It is best not to attempt to estimate accurately colours deeper than that produced by 0.06 m.grm. of ammonia in 0.50 c.c. of water.

Notwithstanding Mr. Wanklyn's assertion to the contrary I believe perceptible ammoniacal vapours in the laboratory are decidedly objectionable, and therefore other analyses involving the use or evolution of ammonia or ammoniacal salts should not be permitted in the same room at the time the water analysis is made.

It is stated that the standard solution of ammonium chloride should never be run into the comparison cylinder after the Nessler test has been added, because a turbidity is thereby produced which spoils the colour estimation. While this is generally true for the addition of more than 1 c.c. of Wanklyn's ammoniac chloride solution, I find that if the comparison test already made is not strong enough it may often be enforced by a few tenths of 1 c.c. of the NH_4Cl solution without producing any turbidity at all. Care should be taken, however, to stir very thoroughly with the pipette, or the colour may not increase perceptibly. Sometimes a peculiar turbidity will occur, however, on the slightest after-addition of NH_4Cl . Conversely, when the comparison test has been made a little too strong, a few tenths of 1 c.c. of NH_4Cl solution may be added to the cylinder containing the distillate, so as to make the colours exactly similar, and the amount of this addition is deducted from the amount of NH_3 found in the comparison tube. Greater care must be taken in this case, however, to avoid producing a turbidity, since the distillate cannot be replaced without repeating the whole analysis. This method of working economises both time and the amount of Nessler solution used in each analysis.

For the process of Nesslerising I find it convenient to use cylinders made by being blown from perfectly colourless test-tube glass, free from lead, care being taken that all the set of tubes are of the same diameter (or rather

capacity) and that they have good flat or slightly depressed bottoms so as to stand well unsupported. I prefer them to be of such size that 50 c.c. of liquid make a column about five inches in height, the tube itself being 15 centimetres in height and 22 or 23 millimetres in diameter. Three dozen of these cost me at the rate of seven cents a piece, and they are all very nearly of the same capacity with only two or three exceptions. A moulded base is very unsatisfactory.

The colour is best determined by looking perpendicularly down through the cylinder placed on a white porcelain tile, checking by raising the cylinder vertically an inch or two and observing again, or placing a smaller piece of tile at an angle of 45° beneath it, and also by holding the two cylinders side by side, flat against a white tile held vertically and opposite to the light. The Nesslerising should be done close to a window, for which perhaps a northern exposure is best, although this may not be important. I do not at all like Dr. Frankland's method of observing the colour of the meniscus by viewing it from above at an angle of 60°. Perhaps I should call this Prof. Miller's method, it being first suggested, I think, by him.

In point of economy of time, a burette holding 15 or 20 c.c. is preferable to a pipette for the delivery of the NH_4Cl solution. It may be of the ordinary Mohr pattern, a glass stop-cock being both unnecessary and troublesome.

In several cases in my experience the distillates containing the free ammonia had a peculiar odour. In one instance where the free ammonia was very large the distillate possessed what may be described as an "earthy" odour. In this case the albumenoid ammonia was remarkably small in amount. Tidy's permanganate method also showed an extremely small amount of oxidisable organic matter. To this case I shall have occasion to refer at a future time.

In another case of the water of a terribly polluted well, situated in the basement of a residence, on distilling with sodic carbonate, a strong disagreeable odour was noticed in the free ammonia distillate. This odour was similar to, but more intense than, the odour which the water itself possessed on being warmed. The free ammonia was 2·860 parts, and the albumenoid 0·512 part per million. The chlorine nitrates and total solids were all very low in amount. Sewage contamination was therefore improbable. The colour of dilute permanganate was, however, discharged rather rapidly. The water had an opalescent, or whitish, appearance in a flask, and there was a large amount of floating sediment of a fungoid character of very peculiar appearance as shown under the microscope. Some of these masses were groups of regularly distributed white opaque spheroids, while one resembled nothing better than a fragment of the most delicate white floss of fine filaments mashed together in a dense white mass nearly as broad as long. I can find no illustration of microscopic fungi at all closely resembling these substances. The special point to be considered just now is the odour occurring in the free ammonia distillate. It seems very probable that this was due to organic matter which volatilised unchanged on boiling with sodium carbonate, and although condensed with the free ammonia was not estimated as ammonia, and was consequently lost in the analysis. This appeared to me to be the explanation at the time of the analysis, October, 1880. It did not, however, occur to me at the time to repeat the distillation with alkaline permanganate alone for the total ammonia, as suggested by Prof. Remsen, of Johns Hopkins University, and also lately by Mr. Marsh, of Princeton College, in a paper in the *American Chemical Journal*, vol. 4, No. 3. The authors have shown that there is frequently a considerable discrepancy between the added free and albumenoid ammonia determined separately and the total ammonia developed by distilling with alkaline permanganate alone. The latter being always in excess in these cases, seems to indicate a frequently occurring loss of volatile organic matter in the ordinary distillation

for the free ammonia. Hence, it would appear advisable always to repeat the distillation in this manner so as to check the results.

On July 17th of this year I collected myself a sample of water from the fore-bay of the Fairmount Water Works at a point under the stone bridge, and collected at arm's length below the surface of the water. The results of analysis were as follows:—

	M. grm. per litre.
Free ammonia ½ litre used	0·150
Albumenoid ammonia	0·110
	—
Total ammonia by permanganate, ½ litre used	0·260
	0·264
Difference for volatile matter	0·004

This difference is, however, clearly within the limits of error of Nesslerising, and can therefore be rejected, and it is safe to assume that there was no volatile organic matter present in this sample of Schuylkill river water. It would have been better to have used at least a half litre for the total ammonia, but the amount of the sample collected did not admit of it, since the rest was used for the estimation of the oxygen required to oxidise the organic matter by Wanklyn's "moist combustion" method, as described in the fifth edition of his Manual. This gave the oxygen required by moist combustion to be 3·75 m.grms. per litre. This oxygen required for the Schuylkill water has been found to vary at different times from 2·75 to 3·75 m.grms. per litre.

The sample was collected about 10 o'clock a.m., a couple of hours after the fore-bay had been raked free from the grass and rubbish, as is done every morning. The water was not flowing over the dam; therefore, the analysis represents pretty fairly the average condition of the river at Fairmount on that day. A sample collected at the same time at the entrance to the fore-bay gave very nearly the same results.

At the time of this analysis the thorough dredging and cleaning of the fore-bay of Fairmount Works, as recently determined upon by the City Councils, had not yet been commenced.

It may perhaps be shown by future investigation that the differences in the ammonia supposed to be due to volatile organic matter may more frequently occur in the analyses of well waters than of river waters.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 16, 1882.

Prof. J. DEWAR, F.R.S., Vice-President, in the Chair.

It was announced that a ballot for the election of Fellows would take place at the next meeting (December 7). The following certificates were read for the first time:—J. Brock, A. M. Chance, H. C. Foote, W. Fox, J. A. M. Fallon, F. Gothard, Joowansinghji, R. B. Lee, T. Turner, J. E. Tuit. During the evening a ballot was held, and the Scrutators, Dr. Japp and Mr. J. M. Thomson, declared the following to be duly elected Fellows:—J. Ferrier, T. Hughes, J. Hodgkin, F. Jordan, G. Jarmay, W. C. Nicholson, H. H. Robinson, L. Reid, J. E. Stead, G. H. Sharpe, P. G. Sanford, E. S. Spalding, C. J. Waterfall.

Mr. WARINGTON then read a paper entitled "*Contributions to the Chemistry of Tartaric and Citric Acids*," by the late BEAUMONT J. GROSJEAN. Mr. Warington said that for five years, 1870-75, he had worked in the laboratory at Millwall with the author of this paper, who had

since then been the sole chemist till his death, in June, 1882. Mr. Warington had, with the consent of Sir J. B. Lawes, compiled from the laboratory note-books of the late author an abstract of his numerous unpublished investigations:—

1. "On the Different Rates of Loss of Different Specimens of Citric Acid in Dry Air."—Three specimens of different samples of citric acid were powdered and placed in two desiccators over fresh oil of vitriol on April 21, 1880. On May 6, one specimen had lost 0.68 per cent; the second, 6.25 per cent; the third, 8.55 per cent. On May 15 the first had lost 1.75 per cent; the second, 8.55 per cent; and on June 21, the first specimen had lost 8.47 per cent. The theoretical amount of moisture present was 8.57 per cent.

2. "Determination of Citric Acid in Lemon and other Juices." The method used by precipitation with CaCl_2 , &c., has already been described, *Chem. Soc. Journ.*, 1875, 931. It appears that the precipitable acid in commercial concentrated lemon juice is, on the average, very nearly equal in quantity to the free acid present. Thus, in 65 analyses, representing 895 pipes, the precipitated acid averages 99.2 per cent of the free acid; some exceptional samples gave numbers from 85.8 per cent to 103.6 per cent. In bergamot juice the average number from 90 pipes was 98.4 per cent; in lime juice, 91 to 92 per cent; in orange juice, about 68.5 per cent of the free acid was found to be precipitable. Thus, while the determination of the free acid gives trustworthy results with lemon juice, it furnishes with lime and orange juice a very unsafe guide to the quantity of citric acid present.

3. "Influence of Heat on Solutions of Tartaric Acid."—40 grms. of tartaric acid were dissolved in water and concentrated till a crust formed. The acidity was now reduced to 97.9 per cent of the original acid, while the ortho-tartaric acid, precipitated by potassium citrate, was only 74.6 per cent. On diluting and boiling for two hours the solution gave 99.9 per cent free acidity, and 99.9 per cent ortho-tartaric acid. The meta-tartaric acid formed as above is also slowly re-converted into ortho-tartaric acid by standing in dilute solutions at the ordinary temperature. Thus the percentage of ortho-tartaric acid in the above solution increased after standing two months, from 74.6 to 90.

4. "Influence of Sulphuric Acid on the Crystallisation of Tartaric Acid."—Sulphuric acid considerably diminishes the solubility of tartaric acid. Much more tartaric acid crystallises out from a saturated solution in dilute sulphuric acid than from a hot saturated aqueous solution: the latter deposits only 50 per cent of its tartaric acid on cooling, whilst a hot solution in 1 vol. of water, and $1\frac{1}{2}$ vols. of oil of vitriol, deposits 70 per cent of its tartaric acid.

5. "Actions of Solutions of Potassium and Sodium Sulphates on Calcium Tartrate."—In the ordinary manufacture of tartaric acid, moist gypsum is added to decompose neutral tartrate of potash and precipitate calcium tartrate. Under certain conditions this reaction is reversed, and if the solutions of potassium or sodium sulphate be sufficiently strong, practically the whole of the tartaric acid in calcium tartrate may be brought into solution as potassium or sodium tartrate.

6. "Destruction of Citrates and Tartrates by Peroxide of Hydrogen."

7. "Destruction of Neutral Tartrates when their Solutions are Heated with Iron Salts."

8. "Determination of Free Sulphuric Acid in Tartaric Acid Liquors."—To ascertain when enough sulphuric acid has been added to decompose the calcium tartrate, the workman usually adds a few drops of calcium chloride solution: if a precipitate appears in a few minutes, free sulphuric acid is present. It is proved in the present paper that this test with certain precautions as to time and dilution may be used quantitatively.

9. "Determination of Tartaric Acid by Precipitation as Acid Potassium Tartrate."—The ordinary method consists in the precipitation of tartaric acid with an excess of

potassium citrate, washing the precipitated bi-tartrate with a 5-per cent solution of potassium chloride saturated with bi-tartrate, and determining by titration the acidity of the precipitate. This method is subject to two errors, one of excess due to the precipitation of an acid citrate, and one of deficiency due to the solubility of bi-tartrate in solutions of citric acid and potassium citrate. The author concludes that in all accurate determinations it is necessary to make preliminary experiments with graduated quantities to potassium citrate to discover the proportion which gave a precipitate of maximum acidity. This being ascertained, a final determination was made with this quantity, the precipitate thoroughly washed, and its acidity determined. If much sulphuric acid is present the result is usually about 1 per cent in excess of the truth.

10. "Detection of Tartaric Acid in the Presence of Citric Acid."—Cailletet's bichromate test (*Chem. Soc. Journ. abstracts*, 1879, 674) gives satisfactory results.

11. "Determination of Organic Acids from the Neutralising Capacity of the Ash of the Salts."—With potassium or sodium salts the ignition must be effected by a spirit-lamp, i.e., at a low temperature, to avoid loss.

12. "Standardising of Alkali used in Titration."—The best material for this purpose is acid potassium tartrate: it is easily prepared pure, can be dried at 100°, is not hygroscopic, and being of low acidity a large weight can be taken.

Mr. C. F. CROSS then communicated briefly the three following papers:—

"Contributions to the Chemistry of Bass Fibres," by C. F. CROSS and E. J. BEVAN. The authors detail further experiments, showing that lignified fibres are to be regarded as a chemical whole rather than the mixture which is involved in the incrustation theory. Fractional solution in the Schweitzer-Pelouse reagent and precipitation by acid gives amorphous modifications of the fibre substance, exhibiting uniformity in characteristic properties. With respect, moreover, to the property of giving a yellow colour with aniline sulphate, a diminution was observed, and, after a second precipitation, it had disappeared. That this reaction was not due to the lignose itself, but to some product of its decomposition, was confirmed by other experiments. The authors find that the mairagallol of Stenhouse and Groves gives with sodium sulphite the brilliant colour reaction characteristic of chlorinated derivatives of lignose. This, together with similarity of formula, points to a probable connection between the aromatic derivatives of fibres and the tri-hydric phenols. The authors describe a higher chlorinated derivative of jute, $\text{C}_{38}\text{H}_{44}\text{Cl}_{11}\text{O}_{16}$, a body of identical formula, being obtained from *Musa paradisiaca*.

"On the Oxidation of Cellulose," by C. F. CROSS and E. J. BEVAN. By the action of boiling 60 per cent nitric acid cellulose is converted into an amorphous substance, which swells up on washing to a gummy mass. On analysis it gave constant numbers, although obtained from various sources, indicating the formula $\text{C}_{38}\text{H}_{26}\text{O}_{16}$. The authors propose the name oxy-cellulose. This substance yields a tri-nitric ether. In this and other properties it exhibits undoubted cellulosic characteristics.

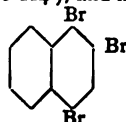
"On the Analysis of Certain Vegetable Fibres," by C. S. WEBSTER. The author has investigated the following fibres:—*Ananassa S.*, *Musa P.*, *Agave*, *Phormium T.*, *Bahmeria P.*, *Crotalaria Y.*, *Linum U.*, *Urtica H.* His results comprise ultimate elementary analyses, determinations of cellulose by chlorination, and a statement of general properties and reactions. None of these fibres appear to preserve the definiteness and uniformity of the jute fibre.

Mr. WARINGTON asked whether the jute fibre was entirely soluble by repeated treatment with bromine and ammonia.

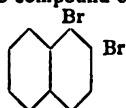
Prof. THISELTON DYER said that he was much indebted to the authors for the explanations which they had given him from time to time of their work in the Jodrell Labo-

ratory at Kew. There was no doubt that the field which lay in the borderland between vegetable physiology and organic chemistry, and in which these chemists had worked, was regarded by many scientific men with the greatest curiosity. The botanists arrived at various results empirically, and were obliged to make up a sort of spurious chemistry to explain them. Thus, in some way, cellulose is converted into lignin; the chemist infers that cellulose is related to starch, and some believe that starch is the starting-point of plant life. This position is challenged by Strasburger, who thinks that cellulose and starch are formed by the breaking up of proteids. It seemed admitted by the chemist that the subject was one of the greatest importance, and yet when one turns to chemical books we find the crust of the subject scarcely broken, the voice of the chemist is silent where the botanist ardently desires information. He was therefore only too glad when two chemists expressed their intention of, at any rate, driving a furrow into this unknown tract. The botanist met constantly with such common substances as starch, cellulose, lignin, mucilage, &c., and yet our state of knowledge about these substances was such that he was almost ashamed to ask a question about them at an examination.

"On the Constitution of some Bromine Derivatives of Naphthalene" (Third Notice), by R. MELDOLA. A careful comparison has been made by the author between Glaser's α -dibrom-naphthalene, produced by the direct action of bromine on $C_{10}H_8$, and the author's meta-dibrom-naphthalene (melting-point 64°), and he concludes that these two modifications are isomeric and not identical. β -dibrom-naphthalene (m.-p., 81°) has been obtained by the diazo-reaction from Rother's brom-naphthyl-amin, thus confirming the view that this modification is a para-compound. By means of the diazo-reaction a new tri-brom-naphthalene has been obtained from the author's dibrom-naphthyl-amin. This substance forms white needles (m.-p., 113° to 114°), and has the constitution—

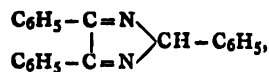


By means of the diazo-reaction the author has obtained a new dibrom-naphthalene from Cosiner's brom- β -naphthyl-amin; it crystallises in oblique rhombic prisms, melting at 63° , and is an ortho-compound of the formula—



By the further action of bromine on ortho-brom- β -acet-naphthalide, the author has prepared a tetra-brom-derivative, of m.-p. 138° . By brominating para-nitracet-naphthalide a mono-brom-derivative has been obtained, isomeric with that of Liebermann and Scheiding; it forms pale yellow needles, m.-p. 224° to 225° . The author proposes that naphthalene derivatives, in which the substituents are in the same benzene nucleus, should be called *homonuclear*, and those in which they are in different nuclei *heteronuclear*. It seems to be a general rule that the homonuclear di-derivatives melt at lower temperatures than their heteronuclear isomerides. Thirty specimens of naphthalene derivatives obtained in the course of this and former investigations, were exhibited by the author.

"On the Constitution of Lophin," by F. R. JAPP. Radziszewski has communicated (*Chem. Soc. Journ. Abstracts*, 1882, 1063) a new synthesis of this substance by the interaction of benzyl, benzaldehyd and ammonia, and he comes to the conclusion that lophin has the constitution—



and rejects the formula proposed by the author, which represents this substance as belonging to the class of anhydro-bases described by Hübner. This latter formula was based by the author chiefly on certain analogies drawn from the reactions of phenanthraquinone with aldehyds and ammonia, and in the present paper it is shown that these analogies are well founded, and that the formula explains the known reactions of lophin more consistently than that of Radziszewski. In conclusion the author describes an experiment which, though not absolutely conclusive, affords a strong presumption in favour of the anhydro-base formula. If it were possible by heating lophin with hydriodic acid and amorphous phosphorus, to split up this body, Radziszewski's formula should yield benzaldehyd, which should be reduced to toluene; the anhydro-base formula should yield benzoic acid. Lophin, when thus heated to about 300° , does yield benzoic acid. This temperature, though high, is 100° below the temperature at which lophin boils without decomposition.

The Society then adjourned to December 7, when a ballot for the election of Fellows will be held, and the following papers will be read:—"On the Condensation-Product of Phenanthraquinone with Ethylic Aceto-acetate," by F. R. Japp and F. W. Streatfield. "On the Condensation-Products of C₆nanthol," Part I., by W. H. Perkin, Junior. "On the Formula of Lophin," by H. E. Armstrong. "On the Molecular Weight of Basic Ferric Sulphate," by S. U. Pickering. "On Certain Brominated Compounds obtained in the Manufacture of Bromine," by S. Dyson.

THE METEOROLOGICAL SOCIETY.

THE opening meeting of the Session was held on Wednesday evening, the 15th inst., at the Institution of Civil Engineers, Mr. J. K. LAUGHTON, F.R.A.S., President, in the Chair.

Eleven new Fellows were elected, viz.: Rev. J. Branskill, F. B. Buckland, C. F. Casella, W. H. M. Christie, F.R.S., A. Cresswell, R. S. Culley, C. Morris, O. L. O'Connor, H. Parker, F.Z.S., A. Rowntree, and D. R. Sharpe.

The papers read were:—

"On Certain Types of British Weather," by the Hon. RALPH ABERCROMBY, F.M.S. The author shows that there is a tendency of the weather all over the temperate zone to occur in spells, associated with certain types of pressure-distribution. In Great Britain there are at least four persistent types—the southerly, the westerly, the northerly, and the easterly. In spite of much fluctuation, one or other of these types will often continue for weeks together, and tend to recur at the same date every year. The value of the recognition of type groups is shown in the following ways:—(1.) They explain many phenomena of weather and many popular prognostics. (2.) In some cases they enable forecasts to be issued with greater certainty and for a longer time ahead. (3.) We can by their means correct statistical results, by giving the real test of identity of recurrent weather, which no single item, such as heat, cold, rain, &c., can do. (4.) They enable us to treat such geological questions, as the influence of changing distribution of land and sea on climate, in a more satisfactory manner than any other method.

"On the Use of Kites for Meteorological Observation," by Prof. E. DOUGLAS ARCHIBALD, M.A., F.M.S. In this paper the author advocates the use of kites for meteorological observation, and describes the mode in which they may be best flown so as not to be mere toys, but scientific instruments, capable of ascending to great heights, remaining steady in currents of varying velocity, and of being manipulated with ease and rapidity by the observer.

"The Meteorology of Mozufferpore, Tirhoot, 1881," by CHARLES M. PEARSON, F.M.S.

NOTICES OF BOOKS.

Messrs. Letts's and Co.'s Diaries for 1883.

THESE annual visitors have once more made their appearance, undiminished in utility and finish, or rather in some cases improved in both. Letts's Gentlemen's Pocket Diary and Almanac (No. 18) in Russian wallet, is substantially but tastefully got up. In addition to the diary, two pages to the week, and a number of blank leaves for memoranda, it contains an almanac, information concerning passports, Inland Revenue duties, University and Law Terms, Customs' tariff, stamp duties, postal information, Officers of State, tables of Sunday Lessons, and other useful information.

Letts's "Housekeeper Enlarged and Engagement Book" contains a ruled space for every day in the year for registering payments made to tradesmen. There is a "concise directory" containing the addresses of 62 firms only. This feature, we are told, has been inserted "under the impression that it will prove of utility to country and foreign residents who may desire to communicate with a respectable firm in any particular trade or profession, and have no means at hand of knowing whom to address." It is not easy to discover why some particular trades have been entirely omitted, nor on what principle the firms mentioned have been selected. It is not often, we think, that foreign residents will "desire to communicate" with a hair-cutter in London. There are registers for the engagements of servants, for gas consumption, for articles lent—a very useful feature.

The Medical Diary is a tall, narrow volume, containing thermometric tables, instructions for the treatment of persons apparently drowned, poisons and their antidotes (in which the compounds of chromium are omitted), a classified list of medicines, average weight and measurement of healthy organs, weight of body, hypodermic injections, therapeutic equivalents, and professional fees. These, as far as concerns attendance before courts of justice, strike us as decidedly too low, a point which we consider ourselves at liberty to notice because the same scale has been held applicable to chemical analysts, microscopists, and other scientific experts.

Letts's Office Diary and Almanac (No. 9) is arranged for the commercial public. It contains lists of banks, for London, the Country, the Colonies and Foreign States, and the usual assortment of statistics, &c. We find also the same curious "concise directory" which we noticed when speaking of the "Housekeeper." This feature seems the more out of place, as offices are seldom unprovided with a London directory.

The Metallic Diary (No. 61) is a neat little pocket volume, containing merely a very concise almanac, a diary allowing alternately three and four days to the page, with spaces for memoranda and things "lent."

Diary No. 13 is a volume bound in cloth, and intended rather for the table than the pocket.

Letts's Pocket Diary and Almanac, a small volume in pocket-book shape, but unprovided with any distinguishing number or mark, contains seven days to the page.

No. 31 is a large-sized, so-called rough, diary or scribbling journal. It contains alternately three and four days to the page, twelve lines being allotted for all the days except Saturday and Sunday.

No. 33 is a very similar publication.

All these diaries are well printed on good paper. Those which we have examined are but a small selection out of a long list arranged to suit every taste, every purpose, and every requirement as regards price.

The School of Mines, Ballarat. Annual Report presented at the Meeting of Governors, held January 24th, 1882. Published by Authority.

THE subjects taught in this institution are chemistry, in the widest sense of the word, metallurgy, geology,

palæontology, mineralogy, scientific mining (including geological surveying), practical mining, mathematics, physics, telegraphy, botany, materia medica, pharmacy, and physiology. The four last subjects, unusual in a mining school, which are explained by the circumstance that the institution serves also as a pharmaceutical school. The staff of Professors is not large—we fear from want of funds. Thus we find Prof. A. M. Smith filling at once the chairs of chemistry, metallurgy, physics, and botany. Prof. M. F. Krause is not less burdened. He teaches not merely geology, mineralogy, palæontology, and scientific mining, but geological surveying, land, mining, and engineering surveying. The services of the lecturer in Oil-painting—a curious feature in a mining school—have been dispensed with.

The museum and the library have been enlarged, but we regret to note that the balance in favour of the School was smaller at the end of 1881 than was the case twelve months previously.

Tables for the Qualitative Analysis of Simple Salts and Easy Mixtures, for the Use of Students Preparing for the Government Science, Oxford and Cambridge Local Examinations, &c. By JOSEPH BARNES, Science Master at the Bolton High School. Galt and Co., Manchester. London: Simpkin, Marshall, and Co.

THIS work consists of 47 pages, and is arranged for "boys and young men who are only able to work in the laboratory for an hour or two during the week." The instructions given, so far as we have been able to examine them, appear accurate. But we fail to see that they have any advantage or superiority over what is to be found in other manuals.

CORRESPONDENCE.

TEST FOR UREA.

To the Editor of the Chemical News.

SIR,—Perhaps some one of your readers will be kind enough to mention a good qualitative test for the presence of urea in a solution containing (besides urea) metallic salts. The process of evaporating down in the water-bath and then adding pure nitric acid is tedious, and in cases where one is limited to time, scarcely available.—I am, &c.,

R.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xciv., No. 18, October 30, 1882.

Result of Experiments made at the Electrical Exhibition on Machines and Regulators with Continuous Currents.—MM. Allard, Joubert, Le Blanc, Potier, and Tresca.—The chief results of these experiments are given in the form of a table.

Rational Conception of the Nature and Propagation of Electricity, deduced from a Consideration of the Potential Energy of the Ethereal Matter associated with Ponderable Matter, and from the Mode of Production and of Transmission of Work accompanying the Variations of this Energy.—A. Leduc.—Continued from *Comptes Rendus*, October 16.

Efficacy of Lightning Conductors.—G. A. Hirn.—The author describes an incident showing that a lightning-rod, even in the most deplorable condition, may sometimes effectually protect an edifice.

Application of the Law of Complementary Colours to the Transitory Decolouration of Yellow Diamonds.—MM. N. Chatrian and Jacobs.—Yellow diamonds may be made to appear white by immersion in the solution of a violet dye. Washing of course removes the film of violet colour, when the original yellow tint reappears.

Chemical Studies on the Sugar-Beet.—H. Leplay.—Studies on the distribution of potassium and calcium salts at different epochs of vegetation.

New Expressions of the Work and the Economic Return of Electric Motors.—Marcel Deprez.—A mathematical paper.

A Modification in the Expression of the Law of Isomorphism.—D. Klein.—The author proposes to modify the statement of the second part of the law in the following manner, as already suggested by M. de Marignac: Isomorphous bodies have either a like chemical composition or present a centesimal composition, differing respectively but little, and containing a group of elements which are either common or of identical chemical functions, forming much the greater part of their weight.

Researches on the Thorite of Arendal.—L. F. Nilson.—This paper will be inserted at length.

Rapid Process for the Determination of Salicylic Acid.—A. Rémont.—To determine salicylic acid, *e.g.*, in wine, the author takes 10 c.c. and agitates them in a test-tube several times with an equal volume of ether, allowing the mixture finally to stand for some time. He then takes 5 c.c. of the ethereal solution and evaporates it with 1 c.c. of water. After the ether has disappeared he makes the solution up to 5 c.c. by pouring the liquid and the washing-water into a graduated tube, of the capacity of 30 c.c., and of the internal diameter of 0.015 metre. Into a tube exactly similar he pours 5 c.c. of a type liquid prepared by dissolving in pure wine the largest quantity of salicylic acid allowed by law, *i.e.*, 0.15 gm. per litre. This type, or standard liquid, the author treats with ether and then with water, exactly as described above. He then adds both to the standard liquid, and to the liquid in question, drop by drop, a dilute solution of ferric chloride (10 grms. of the salt per litre). About three drops are generally sufficient. The depth of colour in the two tubes will show whether the lawful quantity of salicylic acid has been exceeded.

Presence of Ammonia in the Air and in Atmospheric Watery Vapours at Great Heights.—A. Muntz and E. Aubin.—The authors have made their observations on the summit of the Pic du Midi, at 2877 metres above the sea-level. They find the proportion of ammonia substantially the same as what has been observed on the surface of the ground.

Deutsch-Amerikanische Apotheker Zeitung.
Vol. iii., No. 11, August 15, 1882.

Artificial Vanilline.—Dr. Otto Grothe.—Benzaldehyde obtained by heating benzotrichloride with lead nitrate is converted into meta-nitro-benzaldehyde. This is transformed into the amido-compound by means of tin and hydrochloric acid. It is then converted into the diazo-compound and the diazo-group is converted into the hydroxyl-group by boiling. The substance thus obtained is evaporated to dryness with sodium hydrate and the result is heated with methyl iodide to form the methyl-derivative. The latter is nitrated, amidised, converted into a diazo-compound, and yields vanilline on boiling with water.

Purification of Ozokerite.—Dr. Gruber.—In order to obtain from ozokerite a pure white cerosine the author

treats 100 parts ozokerite with 5 parts of fuming sulphuric acid at 80°. The black resinous matter which is deposited in 1½ hours is removed, the dark-green liquid is heated with 10 parts of a dilute solution of sodium silicate to 80°, and agitated for an hour at the same temperature. If 200 parts of water are added the emulsion is decomposed and silica separates out, carrying colouring matter along with it. The yellowish-grey cerosine which floats on the surface is skimmed off and mixed with 50 per cent of a new, specially prepared nitro-carbide (?), and left in contact with it at 80°. The mass is then extracted with 40 to 60 per cent of a petroleum ether, boiling at 40° to 60°, and the latter is distilled off, leaving 70 per cent of fine white cerosine. The nitro-carbide (a nitrogenous charcoal?) is regenerated in retorts by known processes, and the residues obtained during the treatment with sulphuric acid are worked up for paraffin and oil.

Detection of Chloroform.—S. Vitali.—The liquid in question is mixed with a little thymol and potassa, when chloroform is recognised by a reddish-violet colour, which becomes more distinct on the application of heat.

New Method of Recognising the Alkaloids in their Salts.—M. Robin.—To determine a mixture of this kind a small quantity is mixed with twice its weight of powdered sugar. The whole is moistened with twice its weight of pure sulphuric acid. Morphine hydrochloric gives a very fine rose-colour which quickly passes into a somewhat persistent violet. Quinine sulphate gives a greenish colour which becomes light yellow and finally displays a brown ground surrounded by yellow rays; atropine sulphate gives a violet colour turning gradually brown. Strychnine gives a reddish colouration which turns to a black-brown. The behaviour of santonine is similar. Narcotin, a permanent mahogany brown; salicine passes from a brown to a splendid red. Veratrine becomes dark-green; codeine gives a fine intense red (not rose-colour) which soon turns violet, and codeine a bright red.

Recovery of Platinum Chloride and Ammonium Molybdate.—Jul. Post.—All liquids containing platinum chloride are collected together and precipitated with a sufficiency of potassium chloride, let settle for 24 hours, the supernatant liquid drawn off, and the precipitate rinsed into a porcelain capsule. Then all residues of potassium-platinum chloride existing on filters are collected, the empty filters are boiled several times with water, and the solution is poured into the porcelain capsule. Sodium carbonate is then added till an alkaline reaction is produced, and the whole is heated for some hours in the water-bath with occasional stirring. As soon as the platinum has formed a black deposit and the liquid retains merely a faint yellow colour from organic matter, the liquid is filtered, the platinum black is washed first with boiling water, then with boiling nitric acid, and then again with boiling water till the liquid is free from chlorine. The precipitate is dried at the ordinary temperature, and may be at once converted into platinum chloride. For regenerating ammonium molybdate the acid and the alkaline residues are collected apart. The acid liquid is drawn off clear and evaporated in a porcelain crucible to about $\frac{1}{10}$ of its bulk. Almost all the molybdic acid is deposited as an incrustation. When cold the acid liquid is poured off, the crust is washed repeatedly with cold water and poured to the acid liquid, and the whole set aside. Next the ammoniacal liquid is drawn off or filtered, added to the crust in the porcelain capsule, and heated till this is dissolved. Then the solution is filtered and evaporated to crystallisation in the water-bath. The crystals of ammonium molybdate are washed with a little water, the washings mixed with the mother-liquor and again evaporated to crystallisation. The crystals are again washed with a little water; the washings, the mother-liquor, and the solution set aside are mixed, precipitated with sodium phosphate, and put in the bottles set apart for storing alkaline solution.

Detection of Phenol in Creosote.—For this purpose the following reactions are employed:—According to Rust two-thirds collodion give a clear solution with creosote, but a gelatinous mass with phenol. An alcoholic solution of ferric chloride gives, according to Clark, with creosote a bluish colour, turning to a dark green, but with phenol a brown. An aqueous solution of the same salt gives, according to Read, no change, but with phenol a blue colour. Creosote dissolves in glycerin, and is precipitated on the addition of water. Phenol dissolves also, but is not reprecipitated by water. Baryta-water in excess gives a turbid solution with creosote, but a clear solution with phenol.

Journal de Pharmacie et de Chimie.
Tome vi., September, 1882.

New Reaction of Urine and Milk.—M. Ch. Richet. —Potassium iodhydrargyrate is not decomposed by urea or uric acid, but it is instantly attacked by the extractive matters present in urine, and metallic mercury is thrown down in proportion to their quantity. The same reagent is decomposed by milk. Milk contains an imperfectly defined principle, which, like the ptomaines, instantly reduces potassium ferricyanide to ferrocyanide.

Moniteur Scientifique, Quesneville.
September, 1882.

Analysis of Beer.—H. Bungener.—A continuation from the June number. The author treats at length on the determination of alcohol and extractive matter; on the degree of concentration of the wort before fermentation, the determination of the albumenoid matters, the ash, the phosphoric acid, the acidity, and the glycerin; and, lastly, on the detection of antiseptics and of substitutes for hops.

Review of Biological Chemistry.—MM. de Bechi and H. Gall.—A selection of abstracts, chiefly from German journals.

Review of Foreign Chemical Researches.—G. de Bechi.—A series of extracts from the *Berichte der Deutsch. Chem. Gesell.* and the *Annalen der Chemie*.

Alfred Naquet's Patent.—The specification of a patent for dyeing the hair with preparation of bismuth.

New Apparatus for Filtration.—Paul Casamajor.—From the *American Chemist* and the *CHEMICAL NEWS*.

The Industrial Society of Mulhouse.—At the meeting of the Chemical Committee, May 10, M. H. Kœchlin read a paper on the fixation of colours by means of double mordants (see *CHEMICAL NEWS*, p. 179).

M. Goppelsröder read two sealed papers deposited on March 29 and April 22 last, treating of the use of the galvanic current for the simultaneous formation and fixation of colouring-matters upon the fibre; for discharging colours fixed upon a tissue, and thus producing designs upon a self-coloured ground; for discharging colours and producing simultaneously coloured designs on the discharged parts, e.g., aniline-black upon Turkey-red or vat-blue; preventing the oxidation of colours during printing; preparing solutions of reduced colours, &c.

At the meeting of July 12, M. H. Kœchlin read a paper on the application of pyro-gallo-quinone in dyeing. Pyro-gallo-quinone is formed spontaneously from alcoholic mixtures of quinone and of pyrogallie acid, and is deposited in the course of a few days in the form of brown crystals. For quinone may be substituted chloranil. Pyro-gallo-quinone is very soluble in ammonia, soda, and alcohol, but sparingly soluble in boiling water. Sulphuric acid dissolves it with a red colour, which disappears on the addition of water. It gives a black precipitate with salts of iron, and a brownish red one with salts of aluminium. Pyro-gallo-quinone dyes a brown with mordants of alumina and chrome, and a black with iron mordants. These

shades resist soaping at a boil and the action of light. The shades are brighter than those of rufigallie acid, which they otherwise much resemble.

The President read a note by M. Jacques on improvements in the manufacture of albumen, and on its decolouration under the action of air, light, and the vapour of turpentine.

M. Noelting communicated, on behalf of M. Prochoroff, an observation concerning stannous acetate. To dissolve stannous oxide relatively large quantities of acetic acid are required. But on adding a certain quantity of ammonium acetate the solubility of the stannous oxide is much increased. There is probably formed a double acetate of tin and ammonium, which for the purposes of the printer has the same properties as those of stannous acetate, and which may be employed with advantage in the reduction of indo-phenol.

Aniline and Alizarin Colours from Petroleum at the Moscow Exhibition.—From the tar obtained in the manufacture of petroleum gas M. Ragosine has exhibited aniline, methyl-aniline, diphenyl-amine, naphthyl-amine, resorcin, rosaniline, safraniline, eosine, phosphine, and paste alizarine containing 10 per cent of actual colour, all obtained from the petroleum of Bahu.

Estimation of Coke and of Volatile Matter in Coal.—From the *Engineering and Mining Journal*.

Manufacture of Bromine.—An account of the process followed in America, taken from the *Engineering and Mining Journal*.

Imitation of Cheese.—T. E. Thorpe.—From *Nature*.

Patents taken Abroad.—Abstracts of the Specifications of certain German and English patents.

Manual of Industrial Hygiene (Review).—Dr. H. Napias.—A notice of a work treating principally on sanitary legislation as regards manufactures, mines, &c.

Hygiene and Maladies of Peasants (Review).—Alex. Layet.—A notice of a treatise on the sanitary condition of rural districts.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., August, 1882.

This issue contains no chemical matter.

Cosmos Les Mondes.

No. 3, September 16, 1882.

The manufacturers of linseed cake in the North of France are said to sophisticate their product with spent maize from the distilleries, from which the oily matter has been extracted.

The Automatic "Vidangeuse" of L. Mouras.—

This instrument is described as affording a perfect solution of the sewage question. It is closed with a water joint, and is said to be inodorous, and to render infection impossible. "By a mysterious operation, which reveals a totally new principle, it transforms all the solid and liquid excreta which it receives in a short time, and without the addition of any chemical agents, into a homogeneous liquid scarcely turbid or coloured, and almost inodorous, holding everything in suspension in the state of filaments or granules almost invisible." The effluent which contains all the elements of the excreta, organic or inorganic, may be used for irrigation. Experiments made with a "vidangeuse" with glass sides are said to have proved that faecal matters introduced along with urine, soap-suds, &c., are completely reduced at the end of twenty-five days (?) Light substances, such as paper after having floated for a certain time, finally disappear and are dissolved in the liquid mass. A bladder adapted by means of a tube above the experimental vidangeuse does not swell out, but shrinks, showing that instead of liberation of gases there is absorption. All this is effected

"without having recourse to any new agent or any strange force, but by the simple fact that the pan closed and filled with water brings into play a force of nature hitherto unforeseen and overlooked."

No. 4, September 23, 1882.

The Reducing Action of Glycerin upon Salts of Silver and the Application of this Phenomenon to Silvering Glass.—Prof. Palmieri.—On adding glycerin to an ammoniacal solution of silver nitrate, after some time the liquid becomes brown, deposits a black substance, and then becomes limpid and colourless. On heating the mixture it takes a deeper and deeper brown colour, turns black, and leaves a steel-grey metallic deposit upon the sides of the test-tube. If to the mixture of glycerin and of ammoniacal solution of silver nitrate there are added a few drops of caustic potassa and the whole is left at rest, after a short time there is a reduction of silver, forming a very brilliant precipitate. It is preferable to add the potassa to the silver solution before pouring in the glycerin. As soon as the liquids come in contact, reduction sets in; a moderate heat greatly favours the brilliancy of the precipitate. If to the above ingredients ether is added, a metallic ring is at once observed at the point of contact, and in a few seconds the reduction spreads through the whole mass. Agitation renders the reduction more uniform. If alcohol is used instead of ether the reduction is more rapid, and the mirror is very brilliant. The actions of light and heat modify this reaction. Darkness renders the mirror more brilliant and adhesive. With potassa alone the best result is obtained between 60° and 70°; with potassa and ether, between 30° and 35°; and with potassa and alcohol, between 40° and 45°. The reaction is complete in from eight to ten minutes.

No. 5, September 30, 1882.

Easy Method for the Analysis of Sodium Hydrocarbonate.—Dr. Lange.—The author first determines the quantity of soda by the ordinary method. He dissolves then 20 grms. of the sample in a litre of cold water, takes 50 c.c., and titrates it alkalimetrically. He adds to the liquid, whence this portion was taken, a determined quantity of ammonia in order to transfer the bicarbonate into a mixture of neutral ammonium carbonate and sodium carbonate. The excess of ammonia remains free. The ammonia used must be free from ammonium carbonate, a condition which constitutes the chief practical difficulty of the process. If barium chloride is added to the solution in sufficient quantity, the sodium and ammonium carbonates are converted into barium carbonate, which is precipitated, and into chlorides. The alkali due to the excess of ammonia remains in the liquid. The quantity of this free ammonia is then determined with the same standard acid which has been used for the alkalimetric process, and the quantity of bicarbonate present in 50 c.c. of the liquid is found by calculation.

No. 6, October 7, 1882.

The deaths are announced of M. Désiré Van Monckoven, well known for his labours in the application of photography to astronomy, and of Georges Leclanché, the well-known electrician.

A paragraph, taken from an American paper, speaks of a hailstone, weighing 80 lbs., which fell near Salina, in Kansas. There were others weighing 4 to 5 lbs.

M. Nordenskiöld maintains that the aurora is a permanent phenomenon in polar regions, being always seen when the sun is below the horizon and when the moon is invisible.

A New Micro-telephonic System.—Prof. Celso Fornioni.—This paper requires the accompanying illustration.

Electric Incandescence Lamps (Continued).—Mr. Swan.—Translated from an English source.

Felspar as a Source of Potash Alum.—John Spuller.—From the *Journal of the Franklin Institute*.

MISCELLANEOUS.

Society of Arts.—The following are the papers which will be read at the Wednesday evening meetings of the Society of Arts, before Christmas:—November 22. J. Hopkinson, D.Sc., F.R.S., "Ice-making and Refrigerating" (Dr. Siemens, F.R.S., Chairman of the Society's Council, will preside). November 29, Sir Frederick Bramwell, F.R.S., "Some Points in the Practice of the American Patent Office." December 6, William A. Gibbs, "The Artificial Drying of Crops." December 13, W. H. Preece, F.R.S., "Electrical Exhibitions." December 20, P. L. Simmonds, "The Utilisation of Waste: A Quarter of a Century's Progress."

An Improvement in Mercurial Thermometers.—Mr. S. G. Denton, F.M.S., 25A, Hatton Garden, has just exhibited, at the Meteorological Society, 46 newly-made mercurial thermometers, constructed in a special manner, the zero of which has remained constant for over twelve months. The thermometers comprised 23 standards and 23 clinicals. To prove that they were newly-made, the pieces of enamel stems were sent to the Kew Observatory and Hall marked, previous to having their bulbs blown. They were then constructed into thermometers, graduated, and returned to the Observatory, and tested throughout. They were then placed under seal by the Superintendent, and remained so for over twelve months, and then again re-tested, the mean amount of change being only about half a tenth of a degree Fahrenheit. A Standard thermometer, made by the same process as above, was also shown, it being verified in 1873 and in 1882, the zero being still constant.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Aniline Dyes.—Will any of your readers tell me of a good work on the chemical analysis of these dyes?—T. B. M.

Vacuum Pump.—I notice in the *CHEMICAL NEWS* of the 27th October an article on some experiments with a patent vacuum pump refrigerator and ice machine at the premises of the Aylesbury Dairy Company, and I shall be extremely obliged if you will kindly inform me whose patent this is, and whether I can obtain a specification of the invention?—W. J. H.

Manufacture of Pure Chemical Reagents.—(Reply to "A.C.")—I do not know if the work of MM. Gérard and Chancel (Rector and Professor of the Academy of Medicine at Montpellier), entitled "Leçons de Chimie," in two parts in 20mo, has been translated into English. This is a work which should answer your purpose very well; it is exclusively for manipulation and the preparation of chemicals for laboratory use. If you are in London, and will call at Messrs. Hachette and Co.'s Library, perhaps these gentlemen will advise you about it.—B. Boisson.

MEETINGS FOR THE WEEK.

SATURDAY, 25th.—Physical, 3. "On Liquid Slabs," by Dr. F. Guthrie. "On Rainbows formed by Reflected Light," by W. Ackroyd.

MONDAY, 27th.—Medical, 8.30.

TUESDAY, 28th.—Institution of Civil Engineers, 8.
Royal Medical and Chirurgical, 8.

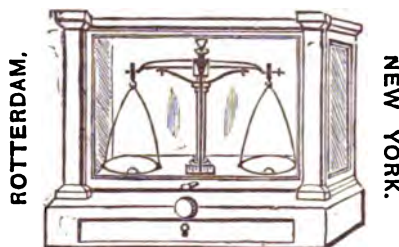
WEDNESDAY, 29th.—Society of Arts, 8. "Some points in the Practice of the American Patent Office," by Sir F. Bramwell, F.R.S.

THURSDAY, 30th.—Royal, 4. (Anniversary).

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ON A NEW FORM OF APPARATUS FOR
ESTIMATING AMMONIA IN POTABLE WATERS.

By C. R. TICHBORNE, LL.D., F.C.S.

ACCORDING to the generally accepted method of examining potable waters, the estimation of minute traces of ammonia existing as such, and the ammonia which results from the oxidation of nitrogenous organic matter, are looked upon as being of the greatest importance in arriving at a conclusion as regards the quality of the water. The process may be concisely described as distilling off a third of the water, and estimating the ammonia in the distillate by Nessler's delicate process, which leaves nothing to be desired as regards its accuracy.

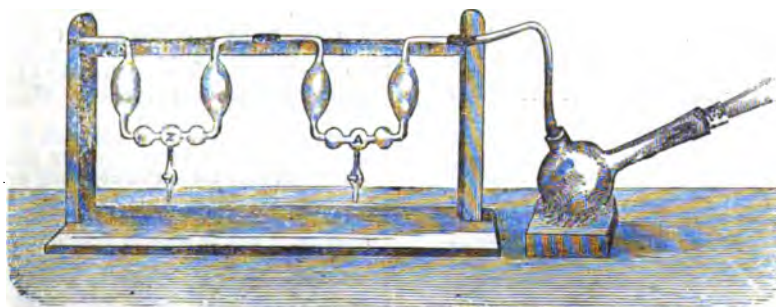
As the amount to be determined does not much exceed one part in ten million parts, it is evident that it is necessary to avoid any accidental contamination from atmospheric ammonia. This is particularly the case in chemical laboratories, where ammoniacal solutions are constantly undergoing evaporation, and the air is contaminated with that volatile base.

The fact is, of course, well recognised by all expert analysts, and is generally guarded against by the use of a special cupboard or chamber, in which the whole operation can be performed. Such a method is more or less imperfect, because the gas-burner used will itself, under certain

At ordinary temperatures very weak solutions of ammoniacal gas (such as we have to deal with in the analysis of potable waters) are fairly permanent; but, in the gaseous conditions, owing to the different tensions of the vapour of the water and ammonia, this stability no longer exists. Again, small traces of ammonia in the gaseous condition are instantly absorbed by water in the non-gaseous condition. These are the two equal sources of error to be guarded against in the distillation of ammonia from potable waters, and, bearing these two points in view, I adopted the arrangement figured.

It consists of a retort fitting into a fairly long-necked receiver, with an india-rubber stopper. The arrangement must be air-tight. The receiver is connected with a bent tube proceeding from its stopper, and connecting it with two bulb tubes of a special form, and marked respectively A and Z. This marking is to prevent any confusion in the hurry of manipulation, as they are exactly the same shape. The bulb-tubes are somewhat similar to a flat Liebig's potash bulb, but with two pear-shaped bulbs on each side, to prevent regurgitation of the fluid, and three absorption bulbs at the bottom. The centre bulb of these three is provided with a glass tap for filling and emptying the apparatus.*

The water to be examined is poured into the retort, and one-third distilled over gently, but at a fairly good rate. If operating upon half-a-pint, the operation should take about an hour. The whole apparatus is previously connected together, and the two bulbs are filled with water free from ammonia (*i.e.*, water which has been boiled rapidly in a flask, until it gives no reaction with the Nessler reagent). The bulbs are easily filled by opening the tap, inserting the point of the tap tube into a beaker of the water, and sucking with the breath gently—at the same time stopping the other end of the bulb-tube by the finger.



conditions, become a source of ammonia. Also, it is evident that a general ammoniacal atmosphere in the adjacent laboratory will find its way into the chamber by the ordinary laws of diffusion.

The capacity of the vapour of water (when in the act of condensing) of absorbing traces of ammonia is something extraordinary, and can only be appreciated by the practical worker.

In distilling potable waters, I was accustomed to work with an ordinary retort and receiver—the latter being provided with a specially contrived mercurial valve. Now, although this was satisfactory in closing the interior of the retort and receiver from general contact with atmospheric impurities, occasionally a regurgitation would take place, and admitted a little of the laboratory air.

The following arrangement has been lately adopted by myself, and, both as regards simplicity and efficacy, leaves nothing to be desired. It is, in fact, so simple that, to a superficial observer, my communication might at first sight appear superfluous, but the importance of the question involved renders any apology unnecessary.*

* "Roscoe and Schorlemmer's Treatise on Chemistry" is one of the most important works upon that science recently issued. In their description of the determination of ammonia in potable waters, there

After the operation is completed, you have the most of the ammonia, if not all, in the receiver, whilst any vapour which might have escaped therefrom is caught in the tube A; at the same time, any atmospheric ammonia which enters by regurgitation is caught in the bulb-tube Z. A is run into the distillate in the receiver, whilst Z is rejected. In practice, it is not necessary that the water in Z should be changed for twenty or thirty operations, providing that an abnormal amount of ammonia is not about in the laboratory atmosphere; but if so, it is desirable to change with each experiment.

If we consider the points that I have dwelt upon as being sources of error, we shall see that this simple apparatus fulfils absolutely the necessary conditions, and that the tube connecting the bulbs A and Z contains an atmosphere perfectly neutral as regards ammonia, because it is the space between two liquids which do not give off ammoniacal gas, and which give off vapour of an equal tension.

is no provision against this fruitful source of error. If the determination were carried on as it is figured at p. 252, vol. 1, of that work, the results would be utterly unreliable in any laboratory where other analyses were being performed.

* Bulbs of my pattern are made by Messrs. Cetti & Co., of London.

I may mention that, on submitting it to experimental proof, the use of an acid in either of the bulb tubes proved a mistake.

It is not necessary to give further details, but I may as well state that in many crucial experiments I have been in the habit of estimating the amount of ammonia in the receiver, and both bulbs A and Z. The following, as regards Vartry water, will serve as an illustration:—

Distillate in receiver,	0.003 per 100,000
Bulb A (nearly)	0.001 "
Bulb Z gave an indication which affected the Nessler, but which was not sufficient to estimate.	

—Scientific Proceedings of the Royal Dublin Society.

ANALYSES OF TOBACCO ASH.

By R. ROMANIS, Chemical Examiner.

THE Government of Burmah are now trying to promote the cultivation of tobacco. I have had occasion to analyse the ash of tobacco grown on different soils in Burmah and in India.

I.—Mengone tobacco grown on the granitic soils near Mandalay, in Upper Burmah.

K ₂ O	17.88
Na ₂ O	4.12
NaCl	0.74
CaO	27.27
MgO	7.58
Fe ₂ O ₃ P ₂ O ₅	6.94
SiO ₂	24.53
SO ₃	10.92

99.98

II.—Grown on alluvial soil at Karrawaddy, in Lower Burmah.

Midrib.	Leaf.
K ₂ O 31.49	K ₂ O 22.65
KCl 2.55	Na ₂ O 4.45
NaCl 1.84	NaCl 1.09
CaO 28.93	CaO 20.78
MgO 6.64	MgO 8.90
SO ₃ 4.40	SO ₃ 7.35
Fe ₂ O ₃ P ₂ O ₅ .. 12.58	Fe ₂ O ₃ P ₂ O ₅ .. 10.27
SiO ₂ 11.56	SiO ₂ 24.56

99.99

100.05

III.—Indian tobacco.

Midrib.	Leaf.
K ₂ O 32.19	K ₂ O 19.02
KCl 0.63	KCl 0.40
CaO 37.40	CaO 36.51
MgOP ₂ O ₅ .. 11.95	CaO.P ₂ O ₅ .. 8.84
MgO 6.12	MgO 7.31
SO ₃ 4.62	Fe ₂ O ₃ P ₂ O ₅ .. 7.76
SiO ₂ 6.19	SO ₃ 6.50
	SiO ₂ 13.76

99.10

100.10

PYROLOGICAL NOTES.

By Lieut-Colonel W. A. ROSS late R.A.

V. ON THE USE OF BORIC ACID AS A REAGENT.

It may be advisable here to explain in detail the *rationale* of the chemical action of this reagent upon substances treated in it before the blowpipe, using the two pyrological examinations of *acmite* (described in the last paper) as an illustration of the difference between its results and those of the reagent chiefly in use at present in Germany—borax.

(1.) In borax, as is well known, almost every composite

* Therefore the guano contains about 12½ per cent of nitrogen.

or mineral powder added before the blowpipe is more or less completely and rapidly dissolved; when, a general *mélange* of contents taking place, that constituent alone which by a stronger colour in solution or other means overpowers the indications of the rest can be recognised. But this is not the only, or even the least serious, drawback to the use of borax as a blowpipe reagent. A reference to Plattner's celebrated blowpipe tables (last edition) shows that out of forty-three pure oxides, whose reactions in borax are described in detail at a great expense of paper and type, only six, or, if the miserable "brown" afforded by oxide of nickel is considered "a good indication," seven can be detected, even when alone, by the use of this reagent, and of these six, three—chromium, vanadium, and uranium—afford the *same* colour—green! Again, what can be a more absurd "test" for the presence of an oxide if it requires, even when pure, to be added to a borax bead in comparatively enormous proportion to give any indication at all, as in the case of iron oxide?

When, on the contrary, a mineral powder is added to a bead of *boric acid* before the blowpipe, three very important phenomena are almost instantaneously offered to the attention of a good observer provided with a decent lens; many more are, of course, presented to the observer provided with a good microscope, but I shall refer to that matter hereafter. (1.) The normal green pyrochrome or coloured flame is *altered* by the merest trace of some substances, as copper. (2.) Effervescence takes place with sulphates as well as with carbonates, an immense advantage, for they are easily distinguished afterwards. (3.) Insoluble borates of added bases are formed within the bead, differing widely, in almost every instance, from each other, in form, colour, and structure. The assay balance shows us that some of these, as lime-borates (which appear in the shape of transparent colourless balls or spherules), are precisely four times the weight of their basic oxides, increasing, of course, very much more proportionally with regard to bulk, so that the merest trace of lime or calcium phosphate (for instance)—as that floating in the dusty air of a room, or in part of a fly—can be not only here recognised by its borate, but, if the observer's balance be delicate enough, quantitatively determined.

Here I may refer to the objection of minuteness urged against this mode of analysis by many chemists, who forget that they are in this objecting not so much to the use of the blowpipe, as of the microscope in chemistry.

The chief action of boric acid, therefore, before the blowpipe, it will be seen, is that of *separation*; precisely the opposite faculty to that of borax, which is to mix everything together. Thus, in a single rapid operation, the pyrologist using boric acid effects—microscopically, but still effects—in many cases what the laboratory chemist can only arrive at by many careful and patient processes of solution, precipitation, filtration, &c., in which a single error or misapprehension, or omission, may render useless the work of hours or even days.

Then, again, there are secondary results, less important than the primary one of separation, but still of great value to the practical chemist or mineralogist. Borax, as is well known, is boric acid combined with a large proportion of basic sodium; the reactions of soda (or other alkali), therefore, contained in minerals, is utterly lost to the pyrologist who uses it as a reagent; he certainly has the "yellow flame B.B." in the case of soda, but considering this is afforded more or less by every silicate and by all silica, the reaction is nearly useless to him. Now, those alkaline aluminous silicates which generally gelatinise with hydrochloric acid (the "zeolites") behave almost similarly in boric acid before the blowpipe; their powder almost immediately "forms an ice-like transparent mass or jelly," dissolving (rapidly or slowly, according to the proportion of silica and alkali) "to a colourless vitreous bead." As this never happens when either of the three oxides, silica, alumina, or alkali, is absent, the phenomenon is obviously a certain and delicate test of the

combined presence of these three substances. By fusing the mineral before the blowpipe (and such minerals nearly always fuse), crushing it, boiling the powder in distilled water (which process removes the greater part of the alkali as soluble alkaline silicate), and treating the residue in a phospho-boric bead—that is, a boric acid bead dipped red-hot in pure phosphoric acid—separation again occurs; silica and alumina appear together as aluminium silicate in the shape of "white, opaque, un-attacked fragments"; lime, as transparent balls, opaque hot if magnesia is present, clear hot if pure, pale green cold if even the minutest trace of iron is present, colourless if pure; iron, as brown-black opaque balls with rust-like matter round them; manganese, as brown transparent balls, colourless after H.P.; cerium, as brown transparent balls, unaltered by H.P., &c.

Your readers will scarcely expect, nor you allow, all the details of these reactions to be entered into here; they can be ascertained by a reference to my little "Manual of Blowpipe Analysis," but I may mention here that the aluminium silicate is again separated by treating fresh powder in "pink P. acid P.P." (i.e., in a bead of "glacial" phosphoric acid previously made pink by the solution in it, B.B., of a trace of cobalt oxide), when all but silica is dissolved; and over 5 per cent of alkali present in the mineral turns the pink bead blue.

I trust the above affords some idea of the *rationale* of one of my processes, and have only to add with reference to the analysis of *acmite* given that the fractions approximating to quantitative results there offered are, of course, based upon the actual proportions as ascertained by the published chemical analyses of the minerals examined; for, as there is no doubt whatever that constituents of minerals are separated as borates by treatment in boric acid before the blowpipe, it is only reasonable to assume that the borate representations (as balls, fragments, &c., which can be boiled out and weighed) bear a relative proportion to the quantity of basic oxides employed.

RESEARCHES ON RUBIDIUM AND CÆSIUM.

By M. C. SETTERBERG.

HAVING had to treat several hundredweights of alums obtained as secondary products in the extraction of lithia from lepidolites, the author has sought for a method of isolating from it the alums of cæsium and rubidium. Having found that the least soluble alums are insoluble in a saturated solution of the most soluble alum, he has based upon this fact a method of extracting cæsium and rubidium.

Several hundredweights of crude alum are dissolved in such a quantity of water that the boiling solution may be of specific gravity 1.152. After the solution has settled it is let stand, drawn off into a second vat, and left to crystallise at the temperature of 45°. The alums of cæsium and rubidium crystallise totally, with an excess of potash alum. The crystalline deposit, added to other similar lots, is submitted again to a similar treatment which enriches it in cæsium and rubidium. This operation is repeated several times, decreasing the quantity of water, and letting the solution become colder. At the outset it is a saturated solution of potash alum, containing mere traces of cæsium and rubidium. The last crystallisation is free from potash alum, but its mother-liquor is not free from rubidium, and is consequently reserved for the treatment of a fresh lot of crude alum. The cæsium-alum is separated from rubidium-alum by the same method. Rubidium-alum is more soluble than cæsium-alum, the difference being greater at 80° than 0°.

To obtain from the alums other compounds of rubidium and cæsium, the author adds to the solution of the alums baryta in such quantity that all the aluminium sulphate is precipitated. The alkaline sulphate remaining in solution yields other salts by double decomposition.

To obtain metallic rubidium, the author calcines in a crucible 1500 grms. rubidium bitartrate with 150 grms. chalk and sugar. He then introduces the charred mass into an apparatus like that used in the preparation of potassium. The reduced metal is accompanied only by a small quantity of black matter. It is rectified—an operation attended with loss. It is better preserved in a sealed tube filled with hydrogen than under petroleum. This process does not succeed with cæsium. The author obtains this metal by the electrolysis of the melted cyanide. To obtain this cyanide in a pulverulent and not syrupy form, it is better to pass a current of dry hydrocyanic gas into a solution of cæsium hydrate into absolute alcohol. He then mixes 4 parts cæsium cyanide with 1 part barium cyanide. This mixture melts more readily than pure cæsium cyanide, and is easily electrolysed.

Metallic cæsium is of a silvery white, soft, easily oxidised, and it decomposes water like potassium. It melts at 26° to 27°, passing through a paste-like state. Its sp. gr. at 15° = 1.88.—*Bulletin de la Société Chimique de Paris.*

ON THE METALS OF CERITE.

By M. B. BRAUNER.

VARIOUS opinions have been given on the place occupied by lanthanum, cerium, and didymium in the periodic system of Mendeleeff. The author thinks that these metals occupy the eighth rank in the following groups with the atomic weights—

III.	IV.	III.-V.
La = 139	Ce = 141.6	Di = 147

If cerium is found in the fourth group, as Mendeleeff admits, it ought to yield a tetrafluoride, the existence of which compound is so far not established. Pure ceric hydrate, $Ce_2O_4 + 3H_2O$, if treated with a solution of hydrofluoric acid, furnishes a brownish amorphous powder of the composition $CeF_4 + H_2O$. On heating this fluoride yields a gas analogous to chlorine, and capable of expelling iodine from potassium iodide.

On treating ceric hydrate with the hydrofluoride of potassium fluoride we obtain a white crystalline powder insoluble in water, the double cerium and potassium fluoride.

Didymium peroxide.—Mosander was aware of an oxide higher than the grey oxide (Di_2O_3), but its composition has escaped the notice of the chemists who have studied didymium (Marignac, Hermann, Zschiesche). MM. Frerichs and Smith obtained some years ago an oxide to which they assigned the formula Di_4O_9 , a composition questioned by MM. Lothar Meyer and Clève. The author suggests that this peroxide contains Di_2O_5 , which would place didymium among the tri- and pentatomic elements. MM. Clève and Nilson regard the peroxide as DiO_4 .

In order to obtain a pure compound of didymium the author submits the sulphate to a series of crystallisations and of fractionated precipitations by oxalic acid. He then reproduces the sulphate, and then the chloride, until the latter gives the spectrum of pure didymium. The atomic weight of this pure didymium has been found = 146.58. The author, like M. Clève, has not succeeded in obtaining a peroxide according to the indications of MM. Frerichs and Smith. After many fruitless attempts to obtain didymium peroxide he has succeeded in preparing this body by adding to a mixture of didymium nitrate and hydrogen peroxide a dilute alkaline lye until a slightly alkaline reaction was obtained. A gelatinous precipitate was produced, greenish or reddish grey according to the depth of the stratum, and forming when dry a reddish powder. Its analysis led to the formula $Di_2O_5 + 3H_2O$, the same hydration as in case of $La_2O_3 + 3H_2O$ and $Ce_2O_4 + 3H_2O$. The author has obtained Di_2O_5 in the anhydrous state by carefully heating basic didymium nitrate to incipient redness in a current of oxygen. It is a porous mass of a

chocolate-brown colour, the density of which = 5.368 (the specific volume of $\frac{1}{2}\text{Di}_2\text{O}_3 = 34.8$). If heated to redness it loses the greater part of the oxygen over and above Di_2O_3 , and the whole at bright redness. Hydrogen only reduces it at a dull red-heat, dilute nitric and sulphuric acids reduce it without escape of gas, and with concentrated acids it gives off ozonised oxygen. Hydrochloric in dissolving it produces only a little chlorine. It is insoluble in hydrochloric acid. It is ten times less soluble in ammonium nitrate than didymium sesquioxide, and twenty-nine times less than lanthanum sesquioxide. This circumstance, to a certain extent, allows of the separation of didymium and lanthanum.

The author has not been able to obtain either single or double salts corresponding to Di_2O_3 , notwithstanding its solubility in dilute acids. On melting this oxide with potassium hydrofluoride there are obtained double fluorides corresponding to the sesquioxide.

The author has found the atomic weight of lanthanum = 138.9, agreeing with the determinations of M. Marignac and M. Clève.—*Bulletin de la Société Chimique de Paris.*

NEW METHOD OF DETECTING DYES ON YARNS AND TISSUES.

By JULES JOFFRE.

(Continued from page 212.)

Blue Colours.

THE blues may be divided into two groups—those upon which potassa has little or no action, and those which it discharges or changes. The former group comprises logwood-blue, ultramarine, vat-blue, Coupier's blue, azurine, cyanine, and alizarine-blue or anthracene-blue.

Logwood-blue is detected by the action of hydrochloric acid, which turns it at once to a fine red. Potassa, without producing any great change, gives it a brownish tint. Ultramarine is decolourised by hydrochloric and nitric acids. Stannous chloride turns it black. It has, besides, a characteristic tone. Ultramarine is used only in printing, and hence care must be taken lest the dressing of the goods should prevent the reagents from exerting its action. The swatch should therefore be first washed with a little ether. This caution applies, indeed, to all colours fixed by printing.

Vat-blues are unaffected by hydrochloric acid, but nitric acid discharges them. In case of wool there remains a yellow colouration due to the action of the nitric acid upon the wool.

Coupier's-blue is but little affected by potassa, which turns it slightly greenish. It is not discharged by nitric acid, which distinguishes it from indigo, but its colour is changed to a dark reddish brown. Hydrochloric acid is without action. Azurine is unaffected by potassa. Hydrochloric acid turns it greenish, and nitric acid gives it a brownish cast, and ultimately decolourises it, but this change requires a long time, whilst a vat-blue is destroyed in an instant.

Cyanine is unaffected by potassa, but it is decolourised by hydrochloric acid, and a washing in water restores the blue. This reaction has some resemblance with that of the aniline-blues, but the reagents are different. The latter are acted upon by potassa much as cyanine is by acids. Stannous chloride acts like hydrochloric acid.

Alizarine-blue is turned to a garnet-red or violet, and is discharged with a fine red colour. This reaction might cause it to be confounded with logwood-blue, though the latter is transformed into a lighter and brighter shade. Logwood-blue, however, becomes slightly brownish when treated with potassa, whilst alizarine-blue remains perfectly unaffected. Certain specimens, recently obtained by a new process, are not at all affected by acids.

The second group comprises extract of indigo, the Prussian blues, azuline, bleu de Lyon, and the "light" blue.

Extract of indigo leaves the cloth white after treatment with potassa and washing with water. Stannous chloride discharges the colour completely in a short time; ammonia has no action. The following is a characteristic reaction for the sulphuric compounds of indigo:—If the cloth is boiled with a weak solution of sodium carbonate it is decolourised, and the water becomes blue. This water, if acidified, will dye a small portion of wool blue.

Yarns or tissues dyed with a Prussian-blue become of a rusty yellow if treated with potassa. If then passed into an acid the blue colour is restored, but not by a prolonged washing in water. The presence of iron may be easily shown on incineration.

Azuline, bleu de Lyon, and light blue present the characteristic reaction of the aniline colours; they are decolourised by potassa, or turned to a pale dirty violet; then, if washed in plenty of water, the original shade is restored in full brightness. Hydrochloric acid merely turns the blue slightly more greenish.

Green Colours.

The green dyes are divided into three groups according to their behaviour with potassa:—

1. The greens which it turns brown or yellow.
2. Those which are discharged, or at least become grey.
3. Those upon which potassa has no action.

The first group comprises sumac olive, and several compound greens, *i.e.*, *vert printemps* dyed with picric acid and extract of indigo, new-green dyed with picric acid and aniline-blue, and Saxony green dyed with turmeric and the sulphuric compounds of indigo. These four colours are distinguished thus:—

Sumac olive is turned brown by potassa, and ultimately light brown. Hydrochloric acid turns it grey, and stannous chloride a brown-grey.

Vert printemps is turned by potassa to a yellow or an orange. Ammonia and hydrochloric acid have no action. Stannous chloride produces no effect at first, but ultimately turns the cloth yellow; water does not restore the green colour.

New-green is likewise turned by potassa to a slightly brownish orange; ammonia turns it yellow; hydrochloric acid gives it a bluish cast, and stannous chloride has no decided action.

Saxony-green is turned a reddish brown by potassa. Ammonia and strong hydrochloric acid give it a brown colour. With stannous chloride it passes first to a dirty green, somewhat brownish, and ultimately to a fine orange-red.

The second group includes iodine-green, methylaniline-green, malachite green, and Schweinfurt-green. The following reactions distinguish these greens from each other and from other greens:—

Tissues dyed with any of the four first-mentioned are decolourised by potassa, but a prolonged washing restores the original colour. Still, if the shade is very light this restoration is difficult. Hydrochloric acid likewise discharges these dyes, and washing in water brings back the original shade. These discharges often leave a yellowish or brownish shade, especially if picric acid has been added, which is not uncommon. Ammonia likewise discharges them. Malachite-green is distinguished from iodine-green by its less blue shade. Schweinfurt-green is turned a greyish blue by potassa; hydrochloric acid turns it a yellow. Ammonia in excess develops the fine and peculiar blue colour of the oxide of copper in contact with excess of ammonia.

The third group includes the chrome greens, emeraldine, and dragon-green, composed of vat-blue and weld.

The chrome-greens are unaffected by all reagents. Chromium oxide may be detected in the ash of the tissue.

Emeraldine becomes of a blackish blue on treatment with potassa. Nitric acid turns it brown.

Dragon-green is unaffected by potassa, but nitric acid turns it to an orange-brown.

Yellows.

Many of these colours leave much uncertainty, being produced by vegetable colours which have a considerable analogy, and which contain the same accessory principles. They may be divided into four groups:—

1. Those which are turned by potassa to an orange or a red.
2. Those which potassa reddens more or less, and which are turned grey or blackish by ferric sulphate.
3. Those unaffected by potassa.
4. Those discharged by potassa.

The first group comprises turmeric, the yellow produced by the action of nitric acid, chrysoine, and chrome-yellow upon woollens.

These four yellows are respectively distinguished by the action of potassa. It turns the first red, the second brown (with decomposition of the fibre), the third to a fine red-orange, whilst the fourth, on long action, is blackened.

The second group includes quercitron, sumac, fustic, Persian berries, young fustic, barberry, and weld. All these dye-wares contain a notable proportion of tannin, the relative quantity of which may be estimated by the darker or lighter shade which the cloth takes when passed into ferric sulphate.

Quercitron and sumac contain the largest proportion of tannin, but sumac dyes only very light shades. Fustic contains less; berries and weld still less. Young fustic gives an orange-yellow. Barberry dyes light yellows, and is chiefly employed in dyeing leather.

The third group comprises annatto, saffron, aniline-yellow, Martius-yellow, and picric acid. Annatto and saffron are not affected by hydrochloric acid, whilst the three others are decolourised, though a plentiful washing in water restores the original yellow.

Annatto is distinguished from saffron by its more orange shade, and because if steeped in sulphuric acid (specific gravity 1.845) the shade become green.

Aniline-yellow verges slightly upon orange; Martius yellow is of a full yellow; picric acid a pale yellow. The last-mentioned is turned red if treated with a strong solution of potassium cyanide.

Aniline- and Martius-yellow may be found upon cotton, fixed by means of tannin, which may cause them to be mistaken for yellows of the second class. But the action of hydrochloric acid removes all doubt.

The fourth group contains merely chrome-yellow upon cotton, which is discharged by potassa and hydrochloric acid, and not restored by washing in water.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 25th, 1882.

Prof. CLIFTON, President, in the Chair.

A PAPER by Mr. WM. ACKROYD, "On Rainbows produced by Light Reflected before entering the Raindrops," was read by the SECRETARY. The author investigated mathematically the rare phenomenon of three bows, and inferred that it would generally take place about sunrise or sunset.

Mr. LECKY thought the effect had a simple explanation. It might be said to be due to two suns, one (reflected) appearing to be below the horizon.

Mr. SHELFORD BIDWELL gave an account of some experiments he had made to test the theory of Dr. Jame-

Moser, that the action of a selenium cell under light was due to the heat rays making a closer microphonic contact between the selenium and the metal electrodes, by expanding the material. He submitted selenium cells to dark heat rays, and found their resistance to rise. Under light rays, however, their resistance fell. He therefore concluded that Dr. Moser's theory was erroneous, and that the fall in resistance due to the light rays is the differential result of the rise due to heat and the fall due to light. He also explained the "fatigue" of a selenium cell by use as caused by its increase of temperature. When the cell cooled again the fatigue disappeared.

Dr. MOSER and Prof. G. C. FOSTER made remarks on this paper, the former suggesting experiments to test the reversibility of the effects observed by Mr. Bidwell, and the latter seeking to reconcile Dr. Moser's theory with the new data.

Dr. JAMES MOSER then read a paper "On a General Method of Strengthening Telephonic Currents." This consists in forming a primary circuit of the telephone transmitter in derived circuit, a set of induction bobbins in derived circuit, and a charged secondary battery, the whole circuit having a very low resistance. Each primary bobbin has a secondary wound over it, and these secondaries are connected "in quantity" to the telephone line, which has at its remote end a set of telephones in derived circuit to the earth or return wire. In this way one line wire serves to supply a large number of separate telephones, a hundred being employed by Dr. Moser to transmit music from the Hippodrome in Paris to the Place Vendôme. The system is applicable to long lines, and the induction noises are reduced by sub-division among the separate telephones.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, October 26, 1882.

Mr. JOHN PATTINSON in the Chair.

THE CHAIRMAN—My duties this evening are very pleasant: to congratulate you on the commencement of another Session, and to invite our President-Elect, Mr. B. S. Proctor, to take the chair. I regret that Mr. Swan is unable to be present, but Mr. Dunn has just put into my hands a telegram from him in London, in which he says that he greatly regrets his absence from the meeting, but that he resigns the duties of President into the hands of Mr. Proctor with very great satisfaction, confident that the duties of the office will be discharged with ability, and that under his guidance the Society will have a year of exceptional prosperity. I have cordially to endorse what Mr. Swan has said, and beg to resign the chair in favour of Mr. Proctor.

THE PRESIDENT (Mr. B. S. Proctor) then took the chair, and said—I have to thank you in the briefest possible manner for the honour you have done me in electing me your President. I will proceed at once to the ordinary business of the evening, and ask the Secretary to read the minutes.

The minutes of last meeting were then read and confirmed.

THE TREASURER then gave his financial statement.

THE SECRETARY then read the Committee's report.

COMMITTEE'S REPORT.

Your Committee have to report to this, the fifteenth annual meeting of the Society, that the number of members at present on the list is 155 against 152 at the same period of last year, showing a very slight increase.

The papers and notes read during the session have been as follows:—"Inaugural Address," by the President, Mr. J. W. Swan; "On the Variations in Composition of Steel Forgings," by Mr. T. W. Hogg; "On Voltaic

Accumulation," by Mr. Swan; "Experiments with Alloys of Lead, Copper, and Antimony, to ascertain their Fitness and Value in the Erection of Sulphuric Acid Chambers," by Mr. John Glover; "On the Albo-Carbon Light," by Mr. John Pattinson; "On the Determination of Arsenic in Copper," by Mr. John Pattinson; "Contributions to the History of the Oxides of Manganese," by Mr. J. T. Dunn; "A Lecture Experiment," by Mr. W. J. Grey; "On the Solubility of Sulphur Dioxide in Sulphuric Acid," by Mr. J. T. Dunn.

The financial condition of the Society is tolerably satisfactory. In place of a deficiency of £12 6s. 9d. at the commencement of last session there is now a balance of £7 4s. 8d. in the hands of the Treasurer.

The Society has this year suffered a severe loss in the death of two its past Presidents, Mr. R. C. Clapham, in December, and Prof. A. Freire-Marreco, at the end of February. Both were actively instrumental in the foundation of the Society, and took throughout a lively interest in its welfare.

The difficulty of procuring papers has often been a subject which the Committee have had to notice. With a view to encourage research and the communication of its results amongst the members, Mr. Scholefield, in February, made the offer to the Society to found a prize or medal to be awarded each Session to the author of that paper which the Committee should think most deserving of it. A set of regulations concerning the award was drawn up by the Committee, and a circular embodying the substance of these was forwarded to each member in April last. The Committee trust that the members' appreciation of Mr. Scholefield's gift will show itself in an increased number of papers during the session.

As the members are aware, the Society of Chemical Industry extended an invitation to the members of this Society to attend their annual meeting at Manchester in July last. During that meeting the question of a possible amalgamation of the two Societies was informally discussed between some of the representatives of this Society and some of the officials of the Society of Chemical Industry. Since then an informal communication from Prof. Roscoe expressing the desire of the Council of that Society for such an amalgamation has been received by the Secretary, and the matter has been discussed in Committee. It was resolved to bring the matter before the members to-night, and to decide finally upon it at the December meeting.

Mr. SCHOLEFIELD moved, and Mr. FRANCE seconded, the adoption of the balance-sheet and the Committee's report.

Mr. MORRISON—I don't know whether I am out of order, but what makes the balance on the right side this year?

Mr. PATTINSON—Perhaps the members have been looked after better; but it is principally due to the fact that the expense of the *Transactions* has been much less this year than last.

Mr. FRANCE—The chief matter in the report seems to be that of amalgamation, and it is one of such importance that I think steps should be taken to bring it before the whole of the members; and, in any circular which is issued, I think the advantages and disadvantages should be clearly set forth, because many of our members do not come to the meetings, as a rule, not from any lack of interest in the proceedings, but because such full and accurate reports of what takes place are given in the *Transactions*.

The PRESIDENT—I am very glad to hear Mr. France introduce this subject. It should be well debated in the Society: it has been well debated in Committee, and we are not all of one mind. It is a complicated question, and we should like much to hear the opinions of members outside the Committee on the subject. Some report of this meeting will go forth in the *Transactions*, and it will thus be brought under the notice of members in time to enable them to form opinions on the subject for the next meeting.

Mr. JOHN PATTINSON—I was scarcely prepared to speak

on this subject, though I have given it a good deal of attention, and it was, I believe, through myself that the matter was first broached. I was at a meeting in London where the Society of Chemical Industry was largely represented, and some of the officers asked me whether an amalgamation would not be practicable with this Society. I expressed no opinion at that time. Since then Mr. Dunn and I have had further informal communication with the members of the Council of the Society of Chemical Industry, at the meeting at Manchester, and in a correspondence which has ensued, it was agreed on their part that in the event of our Society joining in a body, the entrance fee of two guineas should be remitted, and only the annual subscription, one guinea, paid; while they would undertake the publication of our *Transactions*, and defray all local expenses for rooms, circulars, refreshments and so forth. I was very much impressed with the importance of that Society, and with the advantages which would accrue to us from amalgamation. They publish monthly, throughout the year, a very excellent journal, which contains, besides the proceedings of the annual and sectional meetings of the Society, abstracts of papers in other journals, and notes and communications from all sources on subjects related to applied chemistry. Besides the annual meetings, the Society divides itself into sections (of which they intend to have twelve, and are very wishful to form one here), each of which holds its own meetings, and is practically as independent as if it were an individual society.

The PRESIDENT—The Committee have been very much exercised as to the effect which the proposed amalgamation would be likely to have on the award of the Scholefield Medal. Under these circumstances we naturally feel that Mr. Scholefield's views on the subject should have some weight with us, and I should be glad if he would state them to the meeting.

Mr. SCHOLEFIELD—I think there is a good deal to be said both for and against the amalgamation. Mr. Pattinson has very fairly stated the case for the advantages. On the other hand, I think we should lose our identity; lose a great deal of interest which we now feel in our Society. The increased subscription will decrease the number of our members very much; the young men connected with our chemical works will be very likely to resign, and my object last year was directed to the encouragement of that particular class. The reports being published in the *Journal of the Society of Chemical Industry* will tend to decrease our interest. The information contained in their *Journal*, too, can be obtained without a fusion of the two societies; many of our members are already members of the other society—I am for one—and they, I am sure, would be willing to lend their copies of the *Journal* to those who are not, and who are wishful to read them. It has been suggested that those members who live at a distance will withdraw if amalgamation does not take place, and will not continue members of both societies. This is a matter of opinion. I have heard it stated by one of those members that it would have a contrary effect with him: that if we remain separate he could read the same paper at both societies. I am not prepared to say that I decidedly oppose the amalgamation; I only press for the postponement of our decision on the matter, so that in the meantime we may have it thoroughly discussed and considered. I think we should make a considerable sacrifice if we joined it, and I should like to see how we work separately for another year.

The PRESIDENT—The report of this meeting will go out to the members, and we propose to have the subject fully discussed at the November meeting, and that then a voting paper should be sent to the members, and the matter finally settled in December.

The adoption of the balance sheet and the Committee's report was then carried.

The name of Mr. A. M. Lytle, North of Ireland Chemical Company, Belfast, was read for the first time.

Mr. B. S. PROCTOR then delivered the following—

INAUGURAL ADDRESS.

The most important function of the President of a Chemical Society is to stimulate the chemical activity of the members by an action parallel to catalysis.

By his own molecular activity he should bring into play the affinities which are capable of developing new matter, without himself entering into combination with other molecules, in such a way as to deprive them of their individuality.

This function of your leading officer is much more easily exercised when his habitual work is intimately associated, either practically or theoretically, with the daily occupations of the members in general.

Unfortunately this is less the case with me than with any of the gentlemen who have filled this office before me. On this account I shall have to claim a large share of your indulgence and assistance.

Looking back a year, our Society has lost two of its most eminent members, one distinguished for his extensive acquaintance with the chemical resources of the district, and the readiness with which he became the exponent and historian of its technology. The other, pursuing the paths of pure science, occupied a position of vantage not practically within the reach of technical chemists—a position which enabled him to meet each of us as an equal on our own ground.

It will be impossible for me to interest you as the former would have done by reviewing the technical changes of the past, and the prospects of the future for chemical manufacturers, or to trace the development of chemical laws, and recount the discoveries of recent years as would have been an easy task to the latter; but as every man's experience, and every man's train of thought, has necessarily something of individuality to distinguish it from that of his fellows, and as each may profit to some extent by noting the facts or the fancies of his fellows, I will endeavour to lead you as it were on a holiday excursion, away from the technical department of our studies, where everything turns on the pivot of cost, and away from the purely scientific side, where all is excluded but experimental investigation and mathematical law.

I desire for the present to get beyond the walls of the shop and the boundaries of the college. I desire to feel the freedom in which the schoolboy rejoices who has escaped from the customary restraint. I wish to be at liberty to say things which may be fanciful or imaginative, but I trust not foolish. Fancy has its duties in philosophy, though not in science. Fancy develops a multitude of half-truths, which by the treatment of science are decomposed, evolving an atom of truth and eliminating an atom of error—so truth is established, which would have lain dormant had not fancy thrown down the gauntlet to science. Our speculations are evolved by the philosophical use of the imagination, from the unsystematised truths which may be regarded as the waste-material of science. Professor Mills says—"The roadway on which chemistry now runs has been elevated by the rubbish of at least 2000 years." It is my ambition now to scrape together a little heap of such rubbish.

It seems to be the natural desire of a chemist to see with his mind's eye the atoms and molecules, which can no more be seen through the microscope than by the unaided eye. While endeavouring thus to see the constitution of matter, we are told on the one hand that we may relieve ourselves from the idea of matter altogether, and be content with resolving all things into force;† and, on the other hand, we are told that force, in all its many manifestations, may be resolved into matter and motion. We are told at one time that force cannot act at a distance, that attractions are all resolvable into the effects of impacts of molecules in motion; and at another we are

told that the molecules of solid bodies do not touch one another, the space occupied by the actual matter being small compared with the space separating the atoms from one another. We are told that attraction, as hitherto understood, is irrational because it is inconceivable. It is pointed to as an absurdity that force should throw out its boat-hooks and draw two masses of matter together. To my mind the conception of a repelling force is just as difficult as an attracting, and I am compelled to admit that, where both are inconceivable, there is not much to determine us in rejecting one if we cannot equally do without the other. But we may dismiss them both, repulsion most simply by supposing it to result from the rebounding of atoms in collision; and we get rid of the idea of attraction by a speculation just one step more complicated, in supposing it to be caused by the collisions of atoms preponderating in one direction, the attracting bodies shielding one another on one side, and so being forced together by the impact of atoms on the opposite sides; but for these speculations to be entertained we have to assume that atoms can pass through masses with nearly perfect freedom, which does not accord with our usual ideas of matter. To help us in our craving for an explanation of everything, the existence of a luminiferous ether is assumed, and it is endowed with hypothetical properties to suit every difficulty. It is assigned a position intermediate between matter and force. It is supposed to fill all space and penetrate all bodies. It is supposed to be the basis—the physical basis perhaps we might say,—of heat, light, electricity, magnetism, &c. Its movements are supposed to be the cause of polarity and induction. Perhaps they are, if the ether has any existence. On the present occasion, as I have stipulated for a full play of the imagination, we will assume the existence of the ether, the existence of matter, of atoms, of molecules, of spaces between them, of repulsions, attractions, polarities, molecular movements, and whatever else the exigencies of the moment demand.

The middle-aged chemist of the present day was taught in his youth that the general properties of matter included ponderability, size, shape, &c. That matter was distinguished from immaterial forces by its ponderability, the forces being spoken of as imponderable agents, though the expressions were often used somewhat indefinitely.

Gmelin ("Handbook," p. 2) speaks of the imponderables as *bodies*. Miller, without making the statement in so many words, evidently assumes that "bodies" or matter must be possessed of weight ("Elements of Chemistry," 1855). In looking over these and other books which I revered as unquestionable authorities, quarter of a century ago, I feel tempted to put marginal queries to many paragraphs which point to questionable conclusions.

I propose to take as my starting-point two or three of these marked passages—passages which will probably retain their position and authority for many years to come, but which nevertheless do not harmonise with more recent experience or modes of thought.

Turning to Miller's "Elements" (Vol. i., page 65), the phenomena of solution are explained as the result of the adhesion of the solvent to the solved, overcoming the cohesion of the latter. This can scarcely be regarded as an explanation, but even if viewed simply as a statement it is far from being satisfactory. If we accept the common meaning of the word adhesion, that is "sticking to," it can scarcely be admitted that a liquid sticking to a solid explains its disintegration. Nor is it much more satisfactory as an explanation, though it may be more correct as a statement, to say that the force which commonly manifests itself as cohesion is overcome by another force which commonly manifests itself as adhesion. Cohesion and adhesion may fairly be regarded as effects or manifestations of some form of force, but in a critical enquiry it is necessary to avoid confusion between a force itself and the phenomena by which that force is made manifest. It is scarcely a philosophical statement to say that a pow-

* *Phil. Mag.*, January, 1876.

† *E.g.*, Sir W. G. Armstrong, British Association Address, 1863, &c.

dered substance dissolves more quickly "from the partial destruction of cohesion." Nor can we very readily admit that there is less adhesion between a crystal of sugar and a saturated syrup than between the same crystal and water. How then can we say that solution of the crystal takes place in consequence of the force of adhesion between it and the water in which it is immersed, and remains unacted on by the syrup from the absence of adhesion between a material and its saturated solution?

When a supersaturated solution deposits a crystal, the cohesion is said to overcome the adhesion acting between the solvent and the substance of the crystal, but it can scarcely be admitted that cohesion proper comes into existence till the separation has taken place, though it might be correct to say that the *force which causes cohesion* has caused the separation of the solid from its solvent.

This would naturally lead to the question—"What is the nature of the force which causes cohesion?"

Gmelin ("Handbook," I., 38) says, "If the insolubility of crystallised alumina arose from its adhesion being greater than its affinity for the acid, it ought not to dissolve in the acid after being ignited with potash, but to separate in consequence of its greater cohesion after the potash had been dissolved in the acid." In such a case as this I should say the cohesion of alumina no longer existed. It had been destroyed by the potash; not that any matter nor any force had been destroyed, but that one effect of a force had been destroyed by the diversion of the force to the production of another effect.

(To be continued.)

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 19, November 6, 1882.

Comparative Observation of the Telluric and Metallic Rays as a Means of Estimating the Absorbent Powers of the Atmosphere.—A. Cornu.—This important memoir does not admit of useful abstraction.

Result of Experiments made at the Electrical Exhibition on Machines and Regulators with Alternating Currents.—MM. Allard, Le Blanc, Joubert, Potier, and Tresca.—These experiments refer merely to three systems of electric lighting in which machines with alternating currents are employed with the arc. The results are given in a tabular form.

Process for the Separation of Sulphur from its Gangue.—MM. de la Tour and Du Breuil give a communication on their process for the extraction of sulphur by means of a bath of a temperature higher than its point of fusion. The process has been applied with success to the *sterri* of Sicily, that is, the pulverulent and rich debris, produced by the manipulation of the ore. This refuse cannot be treated in the *calcaroni*, and has accumulated in great quantities. The use of the new apparatus has given a yield of 30 to 70 per cent of merchantable sulphur, —a return superior to that of the best ores treated by the old process.

Relation between the Electromotor Force of a Dynamo-Electric Machine and its Speed of Rotation.—Maurice Levy.—Not suitable for abstraction.

Comparison of the Mercurial Thermometer with the Hydrogen Thermometer.—J. M. Crafts.—The author shows that it is not sufficient to class the thermometers of our laboratories in two categories, according to the presence or absence of lead oxide in the glass, applying

to the one the corrections given for the crystal of Choisy-le-Roi, and to the other those for common glass. Instead of plunging thermometers for comparison into an oil-bath he recommends that they should be heated by the vapours of pure and inalterable substances, such as naphthaline and benzo-phenon.

A Hydrate of Molybdic Acid.—F. Parmentier.—The author has examined the deposit which gradually forms in bottles of the ordinary ammonium molybdate solution as used for the separation of phosphoric acid. The author represents the composition by the formula $\text{MoO}_3 \cdot 2\text{H}_2\text{O}$.

Transformation of the Blood of Animals into a Solid Inodorous Manure by a New Ferric Sulphate.—P. Marguerite-Delacharlony.—The author effects the coagulation of the blood by treatment with an acid ferric sulphate of the composition $\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3$. This salt takes up 12 molecules of water in order to form a crystalline hydrate, and in this manner it solidifies blood.

Passage of Alcoholic Liquids through Porous Bodies.—H. Gal.—Without denying the particular influence of the reciprocal action of a membrane and of a liquid with which it is in contact, the author thinks that this influence is subordinate to conditions of equilibrium with the external medium. If the nature of the liquid and that of the diaphragm play one part, one not less important must be ascribed to the temperature and the hygrometric state of the ambient air. The phenomenon is further complicated by the action of the mass and by the tension of the vapours present. The alcoholic liquid increases or decreases in concentration according as the vapours which it gives off find themselves, on issuing from the membrane in presence of an infinite mass of moist or of dry air. We may even conceive an assemblage of conditions in which the degree of concentration would remain constant, confirming the remarkable analogy demonstrated by H. Sainte-Claire Deville between the phenomena of evaporation and those of dissociation.

Reduction of Sulphates by Living Beings.—A. Etard and L. Oliver.—In this preliminary communication the authors show that certain algæ of the genus *Beggiatoa* and other allied groups have the power of reducing sulphates in solution.

An Allylic Mono-chloric Alcohol and its Derivatives.—L. Henry.—The author has obtained and examined the compound $\alpha\text{CH}_2 = \text{CCl} - \text{CH}_2(\text{OH})$. He prepares it by boiling in a flask with a reflux condenser epibichlorhydrine with a dilute solution of potassa. After boiling for some hours the whole is distilled, when the mono-chloric allylic alcohol passes over in the first portions, and may be totally freed from water by the addition of potassium carbonate. It is a colourless limpid fluid, less mobile than allylic alcohol. Its sp. gr. at $19^\circ = 1.164$, and it boils without change at 136° .

Chemical Studies on the Sugar Beet.—H. Leplay. The exhaustion of the soil is greater and the saccharine richness of the beets decreases in proportion as they take a greater development in volume or in weight. The method of diminishing the exhaustion of the soil is to plant the beets closer together, thus multiplying the points of contact between the soil and the roots.

Reduction of Nitrates in Arable Soil.—MM. Dehérain and Maquenne.—It appears probable that the reducing agent which effects the decomposition of nitrates in soil is *Bacillus amylobacter*.

Direct Fermentation of Starch: Mechanism of this Metamorphosis.—V. Marcano.—This transformation is effected by the action of a microbion on the grains of starch. Diastase cannot act usefully on the stratified granulose unless the layers are ruptured at some point. This is in the first place the function of the microbion.

Disinfecting and Antiseptic Action of Copper.—M. Burcq.—The author shows that workers in copper,

bronze, &c., enjoy a practical immunity against cholera, typhoid fever, &c.

Justus Liebig's Annalen der Chemie,
Band 214, Heft 3.

Action of Phosphorus Penta-chloride upon the Amides of Acids (Second Treatise).—O. Wallach.—In this memoir the author discusses at great length the behaviour of the amides of oxalic acid, the oxalines, oxal-ethylene and its derivatives, the products of the action of bromine upon chlor-oxal-ethylene, the action of water and of acids upon chlor-oxal-ethylene at elevated temperatures, the behaviour of chlor-oxal-ethylene on oxidation, its distillation over lime, di-oxal-ethylene, oxal-ethylene, its distillation over lime, oxal-methylene, oxal-propylene, chlor-oxal-amylene, propyl-glyoxaline, and amyl-glyoxaline. The memoir concludes with considerations on the constitution of the oxalines.

Azaurolic Acids, a Series of Nitrogenous Fatty Bodies.—Victor Meyer and E. J. Constam.—The authors have obtained the first member of the series ethyl azaurolic acid and its next higher homologue, propyl-azaurolic acid. They have not succeeded in preparing methyl-azaurolic acid in a state of purity, though proofs of its existence have been obtained. The material for the preparation of ethyl-azaurolic acid is ethyl-nitrolic acid, obtained from commercial nitro-ethan. 2 grms. of ethyl-nitrolic acid were suspended in 10 c.c. water in a small beaker, placed in a freezing mixture of salt and ice, and 40 grms. of 5 per cent sodium amalgam were gradually added amidst constant stirring. The amalgam, which quickly disappears, occasions a development of heat, but the temperature of the liquid must rise but little above 0°, and should not fall appreciably lower. The intense blood-red liquid is decanted from the mercury and cautiously acidified with sulphuric acid, avoiding a rise of temperature. Fine entangled yellow needles are formed, which are drained from the mother-liquor upon a vacuum filter, and the acid, mixed with crystals of sodium sulphate, is dried over sulphuric acid along with the filter. The acid is purified by repeated crystallisation from boiling alcohol, and appears in shining prisms of a fiery orange-red. Its silver salt is brown, and its zinc and lead salts are yellow. The acid is readily soluble in hot alcohol, but sparingly in ether and water. In ligroine, chloroform, and benzol it is almost insoluble. In alkalis it dissolves with an intense orange-red colour. It is decomposed by treatment with excess of concentrated ammonia, as also by boiling with dilute sulphuric or hydrochloric acid, yielding a highly characteristic colourless substance, which the authors name ethyl-leukazon. The composition of ethyl-azaurolic acid is $C_2H_4N_2O$.

Chloride of Lime and Chloride of Lithia.—K. Kraut.—The conclusions reached by the author are that the formula $Cl.Ca.O.Cl$, expresses the empirical composition of chloride of lime inaccurately; that the formation of bleaching chlorine compounds by the action of chlorine upon solid hydrated oxides is not limited to the presence of a polyvalent metal; and that the decomposition of chloride of lime by carbonic acid is not explained by Odling's formula, but by the action of carbonic acid upon hypochlorites, and by that of hypochlorous acid upon calcium chloride in presence of carbonic acid.

Behaviour of Lupinine with Dehydrating Agents.—G. Baumert.—The author examines the behaviour of lupinine with phosphoric anhydride and with hydrochloric acid at elevated temperatures and under pressure. The former reaction yields liquid bases, which quickly turn brown on exposure to the air. Fuming hydrochloric acid, up to a temperature of 200°, does not split off methyl groups, but successively 1 and 2 mols. H_2O , yielding anhydro-lupinine and dianhydro-lupinine. Metallic sodium has no dehydrating action upon lupinine, but yields a substitution-product behaving analogously to the alcoholate compounds.

Deutsch-Amerikanische Apotheker Zeitung.

Vol. iii., No. 13, September 15, 1882.

Glucose and its Applications.—A notice of the purposes,—mostly fraudulent,—to which glucose is applied.

Communications from the East.—Dr. X. Landerer.—The author states that in Greece immense quantities of raisins and currants are allowed to spoil for want of proper appliances for drying. The value of the olive oil available for exportation is estimated at 200 million francs. The phylloxera has not yet made its appearance. Millions of lemons are wasted yearly in the Island of Poros, but a manufactory of citric acid which was there established failed because the ignorant managers evaporated the juice over an open fire, and converted the acid into a worthless pyro-product.

Galaktine.—This compound, extracted from the seeds of lucerne, is a well-defined chemical individual.

Pharmaceutical Notices.—Under this head follow a number of paragraphs which have no especial interest for our readers.

The Thirtieth Meeting of the American Pharmaceutical Association.—We find here nothing of importance.

Chemical Notes : Preparation of Chlorine from Chloride of Lime.—M. Clossen.—The author proposes to use, instead of the relatively costly "hydrochloric acid," waste-products, such as manganese chloride, ferric chloride, alumina, calcium carbonate, &c., all of which liberate chlorine from chloride of lime.

Improvements in the Electrolytic Precipitation of Metals.—In order to obtain metallic deposits, compact, and capable of taking a polish, the solution of the metal in question is converted into a double potassium oxalate by the addition of neutral potassium oxalate, ammonium oxalate is added in excess and a little sodium carbonate, and the metal is thrown down by connecting the object to be coated with the zinc pole of the battery and plunging it into the solution. The other pole of the battery is connected with a plate of platinum.

Bulletin de la Société Chimique de Paris.

No. 3, August 5, 1882.

Limits of Electrolysis.—M. Berthelot.—Already noticed.

Decomposition of Metallic Formiates in Presence of Water : Production of Certain Crystalline Mineral Species.—J. Riban.—A lengthy memoir, which does not admit of useful abstraction.

Action of Alkaline Hypochlorites upon Phenol.—T. Chandelon.—The author obtains trichloro-phenol and compares its properties with those of the trichloro-phenol produced by the action of gaseous chlorine.

Action of Bromine upon Quinoline and Pyridine.—E. Grimaux.—The author has studied the bromine addition-products of these bodies with the view of comparing them with the bromine derivatives of cinchonine.

The Action of Sulphuric Acid upon Thialdine.—L. J. Erikson.—It results from the author's experiments that thialdine is a secondary base.

Choloidanic Acid.—P. T. Clève.—The author has obtained and examined the cholanic, choloidanic, and pseudo-choloidanic acid, and certain of their derivatives.

Russian Chemical Society.—Session of October 8/20, 1881.—M. Orlovsky gave a communication on the affinities of sulphur and selenium for the metals.

The same chemist proposes the following method for detecting cadmium in presence of copper: The blue solution obtained after the separation of bismuth hydrate is acidified with hydrochloric acid, stannous chloride is added until the liquid becomes colourless, amorphous soluble sulphur is added, and the whole is heated to a boil. All

the copper is thrown down as a black sulphide. Ammonia is added to the filtrate to precipitate the hydrates of tin and cadmium, but the latter re-dissolves in an excess of the reagent. If ammonium sulphide is added to this solution the presence of cadmium is shown by a yellow precipitate. Another process, already indicated by Vortmann, is based on the action of sodium hyposulphite upon the cupric salts.

M. Saytzeff read a paper on the transformation of butyric lactone into normal butyric acid.

M. Miller has obtained dibromated naphtho-quinone by causing bromine in presence of iodine to act upon naphtho-quinone dissolved in acetic acid.

M. Pawloff exhibited Orlowky's apparatus for preparing chlorine.

M. Sokoloff, in transforming mannite into nitro-compounds by the action of concentrated nitric and sulphuric acids, obtains, besides hexa-nitro-mannite, a quantity of a lower nitro-compound. M. Sokoloff announces that when nitric and sulphuric acids act upon lactose, there is formed, besides the known crystalline ether, another ether which is gummy.

M. Wilm announces that pure palladium cannot be obtained by precipitation as a cyanide.

M. Mendelejeff pointed out that among the numerous new metals recently discovered in gadolinite and cerite, only two are distinctly established, scandium and ytterbium.

Nos. 4 and 5, September 5, 1882.

Reciprocal Solutions of Liquids.—Wladimir Alexeev.—The author finds that the reciprocal solubility of liquids is not as simple as the hypothesis of Dossios would require. For certain compounds, such as isobutylic alcohol, the solubility, instead of increasing, diminishes with a rise of temperature. The solubility decreases up to a certain limit, beyond which it increases again as the temperature rises; in other words there exists a minimum of solubility, just as for certain solids there is a maximum of solubility. These two phenomena may have analogous causes, and may be due to the formation of unstable chemical compounds. Certain bodies generally considered as solids may form with water two kinds of solutions. Thus phenol and water if placed in contact form two layers: the lower is a solution of phenol in water, and the upper a solution of water in phenol. The solubility of these liquids in each other increases with the temperature, and at a certain limit (83° for a phenol melting at 36°; 68° for a pure phenol) they melt in all proportions. Many liquids follow the same law, *e.g.*, aniline and water. It appears from the author's researches on the reciprocal solubility of phenol and water, aniline and water, &c., that there is no essential difference between the laws presented by liquids and by solids.

Nascent Hydrogen.—D. Tommasi.—The author shows experimentally that the properties of nascent hydrogen are not inherent in this allotropic state of the gas, but that its reducing power varies according to the chemical reaction by which it has been produced. Its heightened affinity at the moment when it is liberated from a compound depends merely on the fact that it is accompanied by all the heat produced when it is liberated. Hence nascent hydrogen is a synonym for hydrogen + calories.

Researches on the Ferric Hydrates.—D. Tommasi.—All the ferric hydrates appear divisible into two series, the red, α , and the yellow, β . The former are obtained on precipitating a ferric salt with potassa, soda, or ammonia. The β series are obtained by oxidising ferrous hydrate, magnetic hydrate, or ferrous carbonate. Series α readily dissolve even in the weakest acids, and present the phenomenon of incandescence on ignition. Series β are sparingly soluble in acids, either dilute or concentrated, and do not present the phenomenon of incandescence. Ferric chloride dissolves the series α in great quantity, but does not dissolve the series β .

Sulphur Compounds of Silicon.—Paul Sabatier.—The author has obtained a brown body which is either a mixture of SiS_2 and of amorphous silicon, or of SiS_2 and of a sub-sulphide. He has produced, also, SiS_2 in fine white needles, and a yellow pulverulent matter, which is probably a mixture of the ordinary sulphide and the sub-sulphide.

Aluminium Sulphate Free from Lead obtained from Bauxite.—C. Fahlberg.—The author's process consists in the preparation of plumbic peroxide, in its application to the treatment of the solution of aluminium sulphate, and in the generation of the plumbic peroxide. To prepare lead peroxide, 200 parts litharge and 100 parts common salt are ground together in a mill till the mass takes the white colour of lead peroxide. The product is then boiled with a clear solution of chloride of lime till it takes a uniformly brown colour, when it is washed and kept moist for use. To prepare an aluminium sulphate free from iron by means of sulphuric acid and bauxite, or any other aluminous mineral, the solution must be neutral or slightly alkaline, as lead peroxide does not entirely eliminate the iron from acid solutions. For 1 part of iron contained in the solution it is necessary to use 20 parts of PbO_2 (calculated as dry). The peroxide paste is added cold to the solutions, stirring continually, and avoiding a rise of temperature. The solutions should not be too concentrated, especially if the sulphate of alumina contains more than 10 per cent of iron. Care must be taken that all the iron is in the state of a ferric salt. To regenerate the lead peroxide the deposit is filtered in the filter-press, the solid matters are suspended in water, and treated with dilute nitric or sulphuric acid untouched. The author has applied lead peroxide to the analytical separation of other metals from iron.

Decomposition of Certain Metallic Acetates in Presence of Water: Production of Crystalline Mineral Species.—J. Riban.—Not adapted for abstraction.

Action of Potassium Carbonate upon Benzyl Chloride and Benzylene Chloride.—J. Meunier.—The author has successfully applied the reaction of Cannizzaro to the preparation of benzylic alcohol.

Indophenol and Köchlin's Fast Violet.—A. Pabst.—This paper will be inserted in full.

Determination of Potash in Manures.—Edmond Dreyfuss.—This memoir will appear at length.

Russian Chemical Society.—Session of Nov. 12/24, 1881.—M. Alexéeff has modified the picnometer of M. Mendelejeff, rendering it more simple, more easy to clean, as well as better adapted for determining specific gravities between very wide limits of temperature. The vertical position given to the instrument is a great improvement.

M. Alexéeff likewise communicated the continuation of his researches on the mutual dissolution of liquids.

M. Rizza announces that on causing 2 mols. of chloral to react upon 5 mols. of zinc-methyl there is obtained dimethyl-iso-propyl-carbinol and not pinacolic alcohol.

M. Flavitzky sent in a communication on the relations existing between the rotatory powers of certain substances and of their active derivatives.

M. Lubavine presented a hypothesis on the various bodies pertaining to the indigo group, the basis of which is indol. He considers indigo an oxide analogous to allylene oxide.

M. Lipp treats of valeridine regarded as a diamylamine.

MM. Markownikoff and Oglobine have prepared, with the different fractions of petroleum hydrocarbons, boiling between 180° and 280°, an entire series of sulphones.

MM. Beilstein and Wigand obtain mesityl by boiling acetone with acetylene chloride.

M. Wilm indicates a new method for separating and purifying palladium. The filtrate obtained on precipitating platinum as ammonium chloro-platinate is heated with an excess of ammonia. The filtered solution, of a

deep blue colour, contains much copper, and on treatment with hydrochloric acid it deposits a yellow residue, containing according to the relative quantity of the other metals of the platinum group, the palladium salt $\text{PdCl}_2 \cdot 2\text{NH}_3$ either almost pure or a mixture of that salt with a compound of rhodium $\text{RCl}_{15}\text{NH}_3$, in which latter case the residue is of a dirty yellow colour. The palladium salt, if precipitated from an ammoniacal solution a second time by hydrochloric acid, is absolutely pure.

M. Louguinine proposes certain modifications relative to the analysis of organic substances.

M. Mendelejeff expressed the opinion that the persulphuric acid of M. Berthelot presents in its reactions and properties the character of true peroxides, such as those of hydrogen, barium, and sodium. It even combines with H_2O_2 . It is not properly an acid, since it can neither combine with bases nor form salts. He regards it as sulphur peroxides. There is no reason to suppose that hydrogen, barium, &c., can form acids by combining with a larger proportion of oxygen.

Session, Dec. 3/15, 1881.—

M. Sokoloff laid before the Society a new eudiometer.

MM. Markownikoff and Oglobin: communicated a second preliminary notice on the petroleum of the Caucasus.

M. Kissel gave in a communication on the action of acid organic chlorides upon the sodium derivative of nitrethane.

M. Goldstein presented a memoir on the boiling-points of the saturated hydrocarbons of abnormal structure.

M. Tschirikoff proposes the use of palladium for the absorption of the hydrogen evolved in certain reactions in sealed tubes, and even for the quantitative determination of this gas.

M. Diaconoff has determined the specific heats and the evaporation heats of normal propylic alcohol, amylic alcohol (of fermentation), and di-methyl-ethyl-carbinol.

M. Louguinine's method of illuminating thermometers used in calorimetric researches consists in placing by the side of the thermometer Geissler tubes of uranium glass filled with a fluorescent liquid (solution of quinine sulphate or fluoresceine). He thus obtains sufficient light without fear of the disturbing influence due to thermic radiation from ordinary sources of light.

M. Diaconoff exhibited two tubes, acting as aspirating-pumps even at a very small pressure of water, and useful for filtration and for washing precipitates.

M. Zaboudsky made a communication on the carbon hydrate formed at the expense of the combined carbon in cast-iron, and on the determination of this carbon in cast-metal, iron, and steel.

Chemiker Zeitung.

Vol. vi., No. 50, August 31, 1882.

The Municipal Chemical Laboratory in Paris.—A description of a laboratory for the examination of articles of food, drink, medicine, &c.

Alco-carbon Burners.—F. Rüdorff.—The flame is said to give a steady white light, well suited for shops. It is less adapted for dwelling-rooms and work-tables, as the flame has to burn for thirty minutes before becoming serviceable. It is not applicable for street-lighting, as it is very sensitive to currents of air, which cause it to burn with a smoky flame.

NOTES AND QUERIES.

* * Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Tannate of Soda.—Would some of your able contributors kindly give me the formula for the substance known as "Tannate of Soda," with a brief description of its properties, and its effect when added to waters containing carbonates and sulphates of lime and magnesia, also the reactions which would be likely to take place?—G. WATSON.

MEETINGS FOR THE WEEK.

MONDAY, Dec. 4th.—Medical, 8.30.

London Institution, 5.
Royal Institution, 5. General Monthly Meeting.
Society of Chemical Industry, 8. "Incrustations in Boilers, and Purification of Water," by Mr. W. J. Macadam.

TUESDAY, 5th.—Institution of Civil Engineers, 8.

Pathological, 8.30.

WEDNESDAY, 6th.—Society of Arts, 8. "The Artificial Drying of Crops," by William A. Gibbs.

Geological, 8.

Pharmaceutical, 8.

THURSDAY, 7th.—Chemical, 8. Ballot for the election of Fellows.

"On the Condensation-Product of Phenanthraquinone with Ethylic Aceto-acetate," by F. R. Japp and F. W. Streetfield. "On the Condensation-Products of Enanthol, Part I.," by W. H. Perkin, junr. "On the Condensation-Products of Isobutyl-aldehyde obtained by means of Alcoholic Potash," by W. H. Perkin, junr. "On the Formula of Lophin," by H. E. Armstrong. "On the Molecular Weight of Basic Ferric Sulphate," by S. U. Pickering. "On certain Brominated Compounds obtained in the Manufacture of Bromine," by S. Dyson. "The Chemistry of Hay and Ensilage," by F. Woodland Toms. "Note on the Preparation of Diphenylene-ketone Oxide," by W. H. Perkin.

Royal, 4.30.

Royal Society Club, 6.30.

London Institution, 7.

FRIDAY, 8th.—Quekett Club, 8.

Astronomical, 8.

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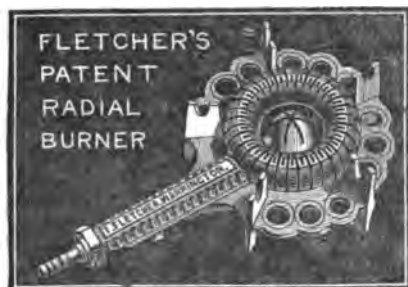
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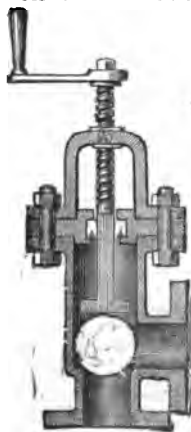
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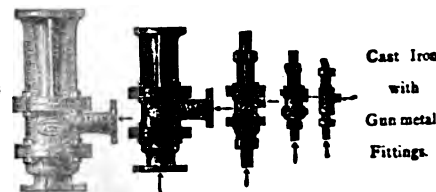
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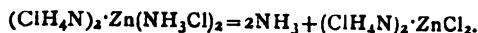
VOL. XLVI. No. 1202.

ON THE LECLANCHÉ CELL, AND THE REACTIONS OF MANGANESE OXIDES WITH AMMONIUM CHLORIDE.

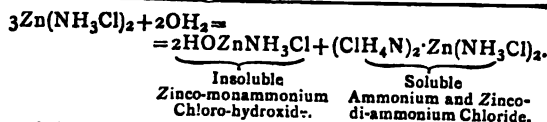
By EDWARD DIVERS, M.D.,
Principal of the Japanese Imperial College of Engineering.

THE occurrence of my name as a misprint for Davis, in an abstract in the July number of the *Journal of the Chemical Society*, of Longi's paper, on the Leclanché cell crystals, makes me desirous to publish that I have never written a communication on this subject. Somewhat oddly it happens, however, that I did work at it some years ago, with the assistance of one of my pupils, Mr. M. Kawakita, and as there seems to be nowhere a very satisfactory statement of the chemistry of this cell, I take this opportunity to publish what I hold to be a more exact account than has yet appeared, based upon experiments in only a few points absolutely new perhaps, but still proving facts apparently little known or considered. Some of these experiments have only just been made. I will first state the action of zinc and of manganese oxides separately upon ammonium chloride solution, and then their combined action upon it.

Zinc is slowly acted upon by a solution of ammonium chloride, hydrogen gas being evolved, and a zinc compound appearing in the solution. The solution acquires an alkaline reaction, and an almost imperceptible odour of ammonia. The nature of the substances reacting, the properties of zinc-di-ammonium chloride, and the gradual separation of this salt in crystals in a Leclanché cell, leave no doubt that the zinc compound going into solution is zinc-di-ammonium chloride in combination with ammonium chloride. But because Longi has found crystals in a Leclanché cell which proved to be slightly impure ammonium chloride (a common experience, the crystals forming merely in consequence of the evaporation of the water), he appears unreasonably to doubt Priwoznik's statement, that $Zn(NH_3Cl)_2$, zinc-di-ammonium chloride crystals, are formed in the normal working of the cell. I therefore mention that Mr. Kawakita found in these crystals nothing but ammonia, chlorine, and 38.6 per cent of zinc, the calculated quantity being 38.23 per cent. The properties of this salt, the knowledge of which bears upon the explanation of the Leclanché cell, are that it is sparingly soluble in ammonium chloride solution, rendering it alkaline, but only faintly ammoniacal. Its solution is not decomposed by dilution with water. It must be regarded as going into solution as double chloride of ammonium and zinc-di-ammonium, $(ClH_4N)_2 \cdot Zn(NH_3Cl)_2$. On heating the solution much ammonia escapes, with most probably the formation of double chloride of zinc and ammonium, thus,—



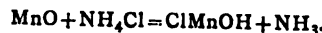
The solution remains clear after boiling. Zinc-di-ammonium chloride is decomposed by water alone into an insoluble part and a soluble part. The insoluble part is voluminous and flocculent when very finely ground salt is employed, otherwise it is granular. It yields much ammonia, hydroxyl, and chlorine to analysis, but being slowly decomposed by washing, it has not been analysed quantitatively. The other and soluble part also consists of zinc, chlorine, and ammonia or ammonium. The action of water is therefore probably expressed by the following equation:—



and the insoluble part hydrated, will be that which Davis examined, and to which he gave the improbable formula, $Zn(OH)_2 \cdot NH_4Cl$.

Manganese dioxide—prepared free from lower oxides by heating manganese nitrate to 165° C., and thoroughly washing the resulting oxide—proved to be unaffected by digesting it for a long time with a solution of ammonium chloride.*

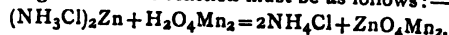
Manganese monoxide is slowly acted upon by ammonium chloride solution when cold, and much more rapidly when hot, ammonia being freely evolved, a little manganese going into solution, and the rest undergoing a striking transformation from its bright green self into a bright skin-coloured substance. This, by protracted washing on the filter-pump, becomes manganous hydroxide, with a very little chloride and peroxide (from aerial oxidation), and is probably, therefore, at first manganous hydroxy-chloride, $HO MnCl$, just possibly ammoniated: it needs further examination. Its formation may be symbolised thus.—



The manganese going into solution will be, no doubt, in the form of double chloride of manganese and ammonium.

Intermediate oxides, both native and artificial, are acted upon by ammonium chloride solution, a little manganese dissolving, and the remaining oxide approaching more and more the dioxide in composition. This oxide, however, has not been reached, even by repeated digestion with fresh portions of ammonium chloride solution. Even excellent pyrolusite yielded soluble manganese, in consequence, no doubt, of the presence of psilomelane, or other manganous compound.

Zinco diammonium chloride dissolved in solution of ammonium chloride adds gradually upon artificially prepared hydrogen manganite, $H_2O_4Mn_2$, not only so as to cause manganese to go into solution, but also as to precipitate zinc on the manganite. For after digesting the manganite in the solution, washing it with ammonium chloride solution, and then thoroughly with water till the washings were free from chloride, zinc could be easily detected in it, though in small quantity. Before this treatment it was found to be free from zinc. The washing with ammonium chloride was practised as a precaution, although it was certain to remove some of the zinc from the manganite. The reaction must be as follows:—



Native well crystallised manganite, ground very fine and subjected to the action of the same solution, did not appear to take up any zinc; nor did artificial sesquioxide and binocide.

Zinc and dioxide of manganese were left in contact in a solution of ammonium chloride. Pure dioxide, prepared by heating the nitrate, was employed for this purpose. Some evolution of hydrogen still took place in contact with the zinc,† both zinc and manganese compounds went into solution, and ammonia was set free. The solution deposited a dark brown substance, manganic hydrate, on the sides of the vessel in contact with the air, just as an ammoniacal solution of manganese always does through aerial oxidation. The solid manganese oxide was removed from the solution after some weeks, and washed

* In "Watts's Dictionary," and Suppl., p. 448, manganese dioxide is spoken of as acting on ammonium chloride solution. This is a mistake, apparently, through inadvertence, as it is not a direct statement, and has no real connection with the context.

† In Sylvanus Thompson's little book on Electricity, hydrogen is said to be liberated on the manganese dioxide when in galvanic circuit, this hydrogen being only slowly oxidised. But this I take to be an assumption, made to explain the rapid fall of the electromotive force of the cell through "polarisation," and gradual rise again when out of action, and not an assertion of observed fact.

twice with ammonium chloride solution, and then well with water. It had changed from a black to a distinctly brown colour, more evidently so after drying in a hot-water oven, and had lost its crystalline sparkle. It yielded both manganese and zinc to a solution of ammonium chloride. To a quantitative examination it yielded evidence of the presence of only 92.5 per cent of dioxide, the rest being manganous oxide and zinc oxide, besides a trace of water (dried at 100°). Careful treatment with metallic mercury failed to reveal the presence of the least trace of metallic zinc, which it was thought might just possibly be mixed with it accidentally.

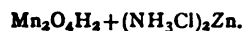
Theory of the Cell.

The above experimental facts lead to the following theory of the action of the cell.

Primary Action.—This is the formation of hydrogen manganite and zinco-diammonium chloride—

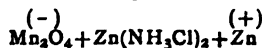


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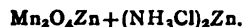


Excess of ammonium chloride holding the zinc compound in solution until the point of saturation has been reached, after which the zinc salt crystallises out as it is formed.

Secondary Actions, causing "Polarisation."—The hydrogen manganite acts locally upon the zinco-diammonium chloride solution, and forms zinc manganite and ammonium chloride; but the formation of zinc manganite takes place much more rapidly by galvanic action when the cell is at work and zinc dissolving, thus—

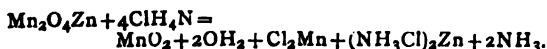


become—



The zinc manganite and the hydrogen manganite, by coating over the manganese dioxide, protect it from the primary action of the ammonium chloride and zinc, and thus cause the "polarisation" of the cell.

Secondary Actions causing Depolarisation.—The ammonium chloride dissolves manganous and zinc oxides out of the manganite, the manganous oxide liberating ammonia and rendering the solution much more ammoniacal than the zinc compound does.



The manganous chloride dissolves in the presence of the free ammonia as a double chloride of manganese and ammonium. By the solution of these oxides the manganese dioxide of the manganite becomes active again. The depolarising action proceeds slower than the polarising, and therefore the battery requires to be left uncircuited in order to recover its full power after use.

Local Actions.—A slight but distinct liberation of hydrogen on the surface of the zinc plate. Absorption of oxygen from the air by the manganese in alkaline solution, hydrogen manganite and ammonium chloride resulting.

Electric Deformations of Quartz.—MM. Jacques and Pierre Curie.—To every method of occasioning an electric disengagement in quartz by pressure, there corresponds a peculiar reciprocal phenomenon. Suppose a parallelepipedon having a surface normal to an electric axis and two normal to the optical axis, when there is a difference of potential between the two surfaces normal to the electric axis, the quartz expands along the electric axis, and contracts in the direction normal to the optic and electric axes, or inversely it contracts in the first direction and expands in the second, according to the direction of the tension. The third direction does not vary.—*Comptes Rendus*.

ON SOME ANALYSES OF A RECENTLY-DISCOVERED DEPOSIT OF GUANO IN AUSTRALIA.

By A. B. GRIFFITHS, F.C.S.,
Member of the Liverpool Association of Science and Arts,
Medallist in Chemistry and Botany, &c.

THE following analyses of a recently-discovered deposit of guano in Australia may be of some use to the readers of this journal:—

	I.	II.
Nitrogenous organic matter and ammonia salts	46.721	46.730
Phosphoric acid	15.021	15.100
Lime	17.999	17.985
Salts of alkalies	1.421	1.405
Sand	2.714	2.713
Water	15.918	16.067
	99.794	100.000

London, November 20, 1882.

NEW METHOD OF DETECTING DYES ON YARNS AND TISSUES.

By JULES JOFFRE.

(Concluded from p. 251).

Orange Colours.

The orange dyes may be divided into two groups, according to the nature of their reaction with potassa—

1. Those which it turns to a red or a brown.
2. Those upon which it has no action, or which it turns more to a yellow.

The first group embraces young fustic, yellow coralline, and two compound oranges, obtained respectively with young fustic and cochineal, and with turmeric and cochineal. These four dyes may be distinguished by their behaviour with potassa. A young fustic dye becomes a red orange-brown; coralline is turned to a splendid purple-red; the young fustic and cochineal-orange to a violet-brown, and the turmeric and cochineal dye to a reddish brown. Ammonia produces the same results as potassa, and perhaps with greater distinctness, the shades obtained by the reaction being brighter. There can be no confusion except with the last two dyes, but here the action of nitric acid removes all doubt. In the orange of young fustic and cochineal it produces no change, whilst it turns that of turmeric and cochineal to a fine red. This reaction must not be too much prolonged as nitric acid turns wool to a yellow. Hydrochloric acid has no action on the oranges of this first group.

The second group comprises modified annatto, hydrated ferric oxide, chrome orange, azo-dinaphthylamine, aurantia, phosphine, and nitro-alizarine. The behaviour of potassa furnishes some indications. Annatto-orange becomes yellow, and chrome-orange on woollen tissues becomes in time entirely black. Phosphine turns to a light yellow, but by washing in water the orange is restored. Aurantia becomes a deeper orange, almost red. Ferric hydrate is turned by hydrochloric acid to a light yellow, which disappears entirely on washing with water.

The washing-water gives the reactions of iron.

Chrome-orange is turned almost white by hydrochloric acid. If the sample is incinerated chrome and lead can be detected in the ashes. Hydrochloric acid also turns azo-dinaphthyl-diamine to a grey-blue and aurantia to a light yellow, which is re-converted to an orange by washing with water.

Annatto, nitro-alizarin, and phosphine are not altered in their tone. These three dyes are distinguished by the action of nitric acid, which turns annatto at first green

and then discharges it; it has no action upon nitro-alizarin, and simply lightens the shade of phosphine. These two last colours are distinguished by the action of potassa, which turns phosphine to a light yellow, whilst it has no action upon nitro-alizarin.

Brown Colours.

We shall examine the brown obtained with sanders wood with potassium bichromate as a saddening agent, catechu, manganese-bronze, aniline brown, and the compound brown dyed with a mixture of orchil, turmeric, and extract of indigo. Sanders-brown is turned slightly greyish by potassa, especially at the edges of the swatch, whilst it has no action upon the other browns. Manganese bronze is discharged by hydrochloric acid, which has no action on the other browns. In the ash the presence of manganese may be detected before the blowpipe.

The compound brown is turned by nitric acid to a deep red, which then grows paler and turns to a light orange-red. Nothing similar is produced with the other browns. The reagents have no effect upon aniline-brown and upon catechu, the tone of the former is much brighter and redder.

Grey and Mode Colours.

We consider here logwood-grey, Casthelaz-grey, carbon-grey, pearl-grey (obtained with extract of indigo and cochineal), and, lastly, the compound colours formed from turmeric, cochineal, and extract of indigo, or from picric acid, aniline-blue, and magenta.

Pearl-grey is turned to a rosy white by potassa, and especially by stannous chloride.

The mode obtained from turmeric, extract of indigo, and cochineal is turned brown-red by potassa, and orange by stannous chloride. That produced with picric acid, aniline-blue, and magenta, is turned yellow by potassa and green by hydrochloric acid.

Logwood-grey is turned to a fine red by hydrochloric acid. Casthelaz-grey turns to a violet with potassa, and to a blue with hydrochloric acid. Carbon-grey (lamp-black) is not affected by any reagent.

Black Colours.

The blacks are readily known by the action of hydrochloric acid. The old gall-black is decolourised; logwood-black turns to a fine red, but on woollens some little time is required.

Madder-black becomes brown, and ultimately a brownish orange. Lastly, aniline-black and lamp-black, which are not affected by the reagents, even the acids, are distinguished by their tones, aniline-black being full and deep, whilst lamp-black is merely grey. — *Moniteur Scientifique*.

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

THE Anniversary Meeting of the Fellows of the Royal Society for the election of Council and Officers for the ensuing year, and for the presentation of the medals in the gift of the Society, took place on the 30th ult., at Burlington House.

The President, Mr. Spottiswoode, in his address, gave a summary of the Society as carried out by the council during the year, and particularised the subjects most worthy of attention.

The medals were then presented as follows:—The Copley Medal to Professor Cayley, F.R.S., for his numerous researches in pure mathematics. The Copley Medal, well-known throughout Europe, though of comparatively small value, is generally considered the highest distinction it is in the power of the Society to confer. The Rumford

Medal, and the balance in money, to Captain Abney, F.R.S., for his photographic researches and his discovery of the method of photographing the less refrangible part of the spectrum, especially the infra-red region. A Royal Medal to Professor Flower, LL.D., F.R.S., for his valuable contributions to the morphology and classification of the mammalia and to anthropology. A Royal Medal to Lord Rayleigh, F.R.S., for his various papers on mathematical and experimental physics. The Davy Medal (in duplicate) to D. Mendelejeff and Lothar Meyer, for their discovery of the periodic relations of the atomic weights.

The following gentlemen were elected Council and Officers:—

President—William Spottiswoode, D.C.L., LL.D.

Treasurer—John Evans, D.C.L., LL.D.

Secretaries—George G. Stokes, D.C.L., LL.D., Professor Michael Foster.

Foreign Secretary—Professor A. W. Williamson, LL.D.

Other Members of the Council—Professor W. G. Adams, F.C.S.; John Ball, F.R.A.S.; Thomas Lauder Brunton, M.D.; Professor Heinrich Debus, Ph.D.; Francis Galton, F.G.S.; Professor Olaus Henrici, Ph.D.; Professor Huxley, LL.D.; Professor E. Ray Lankester; Professor Lister, F.R.C.S.; Professor Prestwich, F.G.S.; Professor Osborne Reynolds, M.A.; Professor Roscoe, M.D.; the Marquis of Salisbury, K.G.; Osbert Salvin, M.A., F.L.S.; Warrington W. Smyth, M.A., F.G.S.; and Edward James Stone, M.A.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, October 26, 1882.

MR. JOHN PATTINSON in the Chair.

Mr. B. S. Proctor's Inaugural Address.

(Continued from page 254.)

We may suppose the crystalline cohesion of the alumina was the effect of a polarity of its molecules which determined their set in the regular crystalline form; a polarity which is not destroyed by fusion with potash, or by union with acids, but which is satisfied or temporarily neutralised by any of these conditions. The polarity which causes crystallisation at one time effects union with acids at another. A confusion arises through regarding cohesion as a force, rather than the effect of a force. Probably cohesion and adhesion differ only in name, the force being the same. We call it cohesion when it causes two molecules of the same nature to join, and adhesion when the effect is the joining of two molecules of different natures. Let us assume that molecules are endowed with polarities, which are the cause of crystallisation, cohesion, adhesion, solution, &c.,—polarities which, like magnetism, are satisfied by meeting with equal and opposite polarities. Let us assume that molecules may have several axes of polarity which may differ much or little in intensity, we may speculate that viscosity is caused by a *multipolar* attraction of approximately equal intensities in different axes, and of a strength intermediate between those existing in solid and liquid states. We may suppose that mobility is the result of equality and feebleness of multipolar attractions; that the colloid state is consequent on equality with strength of multipolar force; that a crystalloid has strong and unequal polar forces which determine the arrangement of the molecules in the lines of their strongest polarities. We may suppose, when sulphate of soda or any other salt dissolves in water, that the polarity of its molecules is satisfied by the attraction of so much water as is required to make a saturated solution; and this polarity being satisfied, further water is miscible with it in all proportions. The greater solubility at higher temperatures probably arises from a weakening of the polarities as the effect of heat, an effect which is evident to us in the case of magnetism and iron. The stronger

polarities probably diminish in greater degree than the weaker till fusion takes place, when the forces are approximately equal in all directions, and further diminish as temperature rises, till volatilisation is effected, when molecular attraction seems to vanish altogether. This all appears reasonable enough in the case of sulphate of soda and water, where the proportion between the salt and the solvent is such that we may suppose the molecules engaged on the phenomena are within the sphere of probable attraction, but when we come to such salts as chloride of silver, sulphate of baryta, &c., how can we suppose that one molecule of the salt can come within the sphere of attraction of so many molecules of water as are required for its solution? This has appeared to me a difficulty in all the theories of solution commonly propounded. If 100 molecules of water by their adhesion cannot overcome the cohesion of two molecules of sulphate of baryta, how is it likely that 1,000 or 10,000 can attack the particle at the same moment?

How can we conceive of one molecule of chloride of silver being maintained in solution by its adhesion to 100,000 molecules of water? And the adhesion of 50,000 molecules of water is insufficient to restrain it from union with some other molecule of chloride of silver which may be adhering to 50,000 contiguous molecules of water?

Hydrogen dissolves in 50 volumes of water, or by weight, 1 in 12,500, or by atoms, 1 in 1400; probably this is much the same as saying that the molecules find freer space for their movements between the molecules of fluid water than between those of the atmosphere of gaseous hydrogen from which the solution is taking place. The active movements in the hydrogen atmosphere tend to throw out molecules into any space freer than the atmosphere, and will so throw hydrogen into the water till the water is as crowded with hydrogen molecules as the hydrogen atmosphere itself, and then it is probable that interchanges will take place, but the number of molecules thrown into the water will be just equal to those thrown back from the water into the hydrogen atmosphere, and so there will be maintained a definite relationship between the proportion of hydrogen "absorbed" or "dissolved" by the water, and the temperature and pressure of the hydrogen atmosphere in contact with it. This doctrine is so nearly the common one in reference to gas and water that my statement is like an oft-told tale. But if we apply the same idea to the solution of chloride of silver it affords us at least some material for thought and speculation. The quantity of chloride of silver in its saturated solution in water is less than the quantity of air in an equal space of an ordinary air-pump vacuum, but more than in the high vacua used for radiometers or Swan lamps.

A cubic inch of air, attenuated to the thousandth of an atmosphere contains $\frac{1}{1000}$ of a grain of N and O. A cubic inch of saturated solution of chloride of silver contains about $\frac{1}{1000}$ of a grain of AgCl. But the highest authorities tell us that even in the most perfect vacua attainable, the molecules are crowded almost inconceivably closely together, and in numbers quite beyond our powers of thought. The limit of solubility seems more probably determined by the relation of the molecular motions of the AgCl to this state of crowding than to any adhesion between the salt and its solvent, using the word adhesion in its customary sense. The flight of molecules of AgCl through the water would give them mean free paths of appreciable length before coming into contact with others, or within influence of their polarities and movements.

The movements of the AgCl in relation to those of the water may be compared to the movements of a comet in relation to a planetary system. The comet comes in and obeys the central commanding force and is temporarily part of the system, but is whirled away again into space, so the mass of AgCl, by a temporary influence of the water, throws off an atom which, passing through a cometic orbit, having too distant a harmony with the aqueous sun to be retained in its system, passes into the aqueous space till it comes under the influence of a molecule or a mass

of its own nature, with which it unites and passes out of solution.

The effect of heat is no doubt to weaken the molecular polarities, thus facilitating the disintegration of solids, but at the same time weakening the polar attraction between the solid and the solvent. The increased or decreased solubility with a rise of temperature will depend upon whether the polar attractions among the molecules of the solid diminish more or less rapidly in proportion to the increased temperature, than the polar attractions between the solid and the solvent. Of course we expect the molecular movements of one drop of water to be just the same as of another, and we know they unite instantly and perfectly. The molecular construction of oil of turpentine or other essential oil we believe to be very different, and probably their molecular movements are inharmonious with those of water, resulting in the small degree of solubility between them, while the complicated and heavy molecules of the volatile oils having sluggish movements dissolve freely among one another.

In the various alcohols we have a step by step increase in complexity of molecular structure, with a like increase in density and decrease in mobility; at the same time we find the light mobile alcohols miscible with water in all proportions, the heavy alcohols insoluble in water but soluble in oils; the light alcohols standing between water and the heavy alcohols, and having considerable inter-solubilities with both.

The molecular motions and polarities of water are probably considerably influenced by most substances which may be dissolved in it, especially in those cases where one body has a conspicuous influence on the solubility of another, with which it does not enter into combination or decompose. Such, for example, as ammonia, which when present in large proportion has power to throw out of solution the double sulphate of copper and ammonia. The molecular relationships of the water are evidently much influenced by the great affinity of the ammonia; they are also much influenced, though in a different direction, by the great affinity of carbonate of potash when added to saturation; the saturated solution not being miscible with a strong solution of ammonia. On the other hand, the sparingly soluble bodies probably have their molecular movements and polarities comparatively little influenced by the water, as in the case of hydrogen and oxygen, which may both be dissolved in water, though only to a small extent, and yet not enter into combination with one another. We regard the liquid condition as that most favourable to the combination of bodies having a tendency to unite, and yet the great affinities of O and H fail to bring them into union. Probably the affinity between the water and these two gases is so small as to exert very little influence on their movements, and leave them virtually in the free and gaseous state, occupying, as it were, only the interstices of the water. The case is necessarily different with ammonia, where the proportion is so great that we cannot suppose it to retain a molecular condition or mobility in any degree approaching that of its gaseous state. And the case is also very different when O and H are condensed upon the surface of platinum, where the amount of condensation is so great as to preclude the idea of a truly gaseous condition of the molecular movements, and where the affinities are brought into effective play. The great affinity of ammonia for water is seen not only in its abundantly taking the liquid form by their union, but also by its power to throw the carbonate of potash out of solution, when passed in the gaseous state through a saturated solution of this salt. Ammonia very much diminishes the solvent power of water for many other salts, but has no appreciable action on the solubility of ether, chloroform, sugar, or gum.

I am not prepared to suggest any more definite relation between a substance and its solvent, than a harmony of molecular movements, and the existence of molecular polarities acting between the solid and the solvent, which enable the movements of the solid to throw off

molecules under the influence of the motions and polarities of the solvent, with rates of frequency peculiar to the solid and solvent under consideration, and allow the re-attachment of the molecules of the solid to one another when the number of molecules of the solid to those of the solvent is beyond a ratio peculiar to themselves.

I think there is every reason to believe that the polarities of crystalline bodies by their inequalities cause the set of the matter in the crystalline form. I think there is also probability, though not yet so strong, that in amorphous or less crystalline bodies the intensities of the molecular polarities are more equal, and that bodies which are capable of taking both forms have polar intensities differing to so small an extent that a slight change of circumstances may determine the orderly or the heterogeneous arrangement of their molecules. It would be reasonable if such were the case, that the amorphous condition should be the less resistant to mechanical or chemical change, *i.e.*, should be softer, more soluble, more prone to enter into chemical combination. To illustrate my meaning, some substances may be thrown down as amorphous precipitates, becoming crystalline by time; the polarities being weak or of nearly equal strengths, the molecules attach themselves together in heterogeneous contact of those points which were nearest at the time of the formation of the new compound, and, being thus less combined, they are more readily dissolved by the mother-liquor. But some crystalline particles get formed, and are always surrounded by mother-liquor holding in solution more than the normal proportion of the salt. The crystalline particles are, therefore, always in circumstances to grow in size by attachment of more molecules drawn to them by the crystalline polarity; this reduces the solution to a strength below that at which it is capable of taking up the amorphous salt. The crystalline part of the precipitate is thus always growing, and the amorphous is constantly being dissolved till all has become crystalline. The whole phenomenon is very beautifully seen by aid of the microscope in the process for detecting traces of strychnine by precipitation with ferricyanide of potassium.

A drop of solution of strychnine on the microscope slide, being touched with a minute fraction of a drop of a solution of the ferricyanide, and the precipitate immediately examined under a half-inch objective, shows an amorphous cloud which quickly commences to exhibit a few crystals of a beautiful star-like shape. Around these the nebulous precipitate rapidly dissolves, leaving a clear space into which the stars expand, while the clouds clear away till all is bright and beautiful. Unless care be taken, it is sometimes difficult to repeat this experiment, as a trace of crystalline salt determines the rapid and less regular crystallisation of the whole precipitate at once.

In this and many other cases the substance is capable of taking either of the two conditions distinctly. There are many in which a precipitate is apparently amorphous, though probably only so in appearance, from being in too minute a condition for its crystalline form to be noted under the microscope, and a considerable number of bodies exist in which no trace of crystalline property has yet been discovered, the most perfect of these being the gelatinous or colloid bodies.

The gelatinous state itself is probably due to polarities in the molecules acting equally in all directions. The hydration of colloid bodies has always appeared to me to be a subject worthy of speculation and of experiment. Its study relates to a debateable condition between the solid and the liquid state. We can trace every degree of change without any clear separation, from the most perfect fluidity through a great variety of watery combinations to the most perfect solidity and the most perfect insolubility, without losing the connection between the water and the solids with which it is brought into operation.

There is the most perfect gradation from the solution of ammonia, which is lighter and more mobile than water itself, through the solutions of crystalloid solids which add but little to the viscosity of the water, to solutions which

are syrupy; to solutions of gums which are mucilaginous fluids or gelatinous semi-fluids; to combinations of water with gelatine or albumen, which, by change of temperature, become fluid in one case or lose fluidity in the other; to silica, which may be precipitated as a transparent gelatinous mass from a dilute solution, or as a pulverulent and opaque precipitate from a concentrated liquor; to clay which in small quantity remains diffused through pure water, with a persistency suggesting a union approaching that of solution, and from which it may be precipitated by hydrochloric acid, and to clay in its plastic state which presents some analogies to hydrated colloids. Thus through many links till at the end of the chain we come to pure siliceous sand and other pulverulent bodies, which retain the one remnant of analogy to solubility, that they are always left in a more coherent state by evaporation of water in which they have been immersed, than by lying in dry contact during any observable time.

I cannot at present enlarge upon more than one or two of the many suggestive links which merit study in this chain; first, as to the great force (molecular polarity I will assume) by which the gelatinous colloids are held together, and how great a force is represented by their union with water; and then to the adhesion, or cohesion of precipitates on the evaporation of water in comparison to the adhesion of the same substances under dry pressure. As regards the coherence of gelatinous colloids glue affords a convenient illustration. One part of gelatine dissolved in 100 of hot water makes a jelly on cooling. One molecule of gelatine confers proximate solidity to 100 times its weight of water; the molecules of gelatine may be regarded as separated from one another by this large proportion of water intervening, and still to have so much hold upon one another—still to be so strongly under the influence of one another's polarities, that they are held in position and not free to move, though the jelly is tremulous and easily broken. We might expect the polarities to increase inversely as the squares of the distances of the molecules, and to become something considerable as the water is diminished, and this is the fact to a larger extent than is often supposed. A solution of gelatine evaporated in glass or porcelain vessels contracts so much, and with so much force, as to tear away the surface of the vessel, thus indicating that the molecular attraction of the gelatine is at least as great as that of glass or porcelain. I have here specimens of glass and porcelain thus fractured. I had long ago heard of such results, but heard of them with a reservation of faith till a few years ago, when experimenting with gelatine, my beaker fell a victim to this adhesive, cohesive, and contractile force. The effect on the evaporating dish is equally interesting. The force evidently exceeds the tensile strength of glass and porcelain, and if measured by pounds per square inch must be something considerable, but probably all the molecular forces would be large—indeed ungovernably violent—if our engineers were reduced to the size of molecules.

If the molecules of gelatine are held together with this great force, the force with which water attacks them must be equally great to enable it to penetrate the gelatine on immersion and expand it as it does. The swelling of a substance by becoming damp is frequently spoken of as the result of capillary attraction. I believe, however, that in most cases, if not in all, where swelling action takes place, it is the result of colloid hydration rather than capillarity. It is worthy of a passing remark, that while gelatine diffuses to a small extent only in water, water penetrates to a large extent into gelatine, and in contrast to this crystalloids diffuse into water, but water does not penetrate into a mass of solid crystalloid, though it diffuses into a solution of the same.

Turning now to another point, which I can do no more than touch upon, we may take pure siliceous sand and wash it with the greatest care in distilled water, finally decanting the water and drying a small quantity of the sand in a beaker by evaporation; the particles of sand adhere to one another and to the beaker with sufficient force to

permit of the inversion of the beaker without the sands falling out, though, if once disturbed after it has become dry, the adhesion instantly disappears, and does not show itself again after a long period of rest in the dry state. What is the nature of this adhesion, and what part the water takes in bringing it about is, as yet, problematical; we note the same effect in all bodies in varying degrees, from gelatine down to sand; it is not proportionate to the solubilities of the bodies in which it takes place. No doubt solubility has an effect of this kind, but we cannot regard the phenomenon as simply dependent on partial solution and the cementing of the undissolved particles, by means of the dissolved portion, left as a residue on evaporation.

The effect is so variable in amount among bodies nearly equally insoluble—for example, sand and clay—sand having the loosest possible adhesion, and clay a considerable one. It is more likely that the superficial molecules in a particle of sand or clay have one side of the molecule free to exert an affinity on the water, and that one side of the molecule is thus in the condition of hydration, the difference being that in hydrated colloids both sides of the molecule have water attached, and the action extends to every molecule in the mass. On this supposition, when the water is evaporated, adhesion should take place wherever two molecules of silica come in contact, and the amount of adhesion should be proportionate to the relation between the size of the particles and the size of the molecules.

In a very interesting paper on regelation and the uniting of powders into masses under pressure, Professor Spring notices incidentally the disposition of powders kept in bottles undisturbed for a length of time, to become united into masses which are more or less strongly coherent as they have been undisturbed for a longer or shorter time, and he attributes this result to a disposition possessed by most substances, but he thinks by crystalline substances especially, to weld when submitted to pressure—to unite promptly and perfectly under powerful pressure, or slowly and imperfectly under the pressure of their own weight. That many powders do agglomerate in our bottles is well known to us all, but the cause of their agglomeration I should think is mainly due to the action of moisture and change of temperature. The tendency to absorb moisture is not confined to deliquescent substances, or to substances commonly known as hygroscopic, but is probably possessed by all matter which has been carefully dried. In non-deliquescent salts the absorption of moisture ceases before the salt becomes palpably moist, but not before the particles are coated with an infinitesimal film of saturated solution of the salt. This film increasing in moist states of the air, and evaporating under the reverse circumstances, is sufficient to cause the agglomeration of the powder by a species of crystalline soldering of one particle to another. The same result would be produced by changes of temperature increasing or diminishing the solubility of the salt in its watery film. There is scope here for a series of careful observations which could not fail to be instructive. Professor Spring's results have had a great interest for me, perhaps the more so, as his conclusions are in some points opposite to my prejudices. He thinks that softness and a crystalline nature are, if not essential, at least favourable to this welding by pressure. Some years ago, when Professor Brayley was lecturing on Physical Geography to our Literary and Philosophical Society, I performed for him an experiment in regelation, in illustration of his remarks upon glaciers, the point being the uniting of two pieces of ice while immersed in warm water. He expressed to me his conviction that it would ultimately turn out that regelation or welding could only take place with matter in a colloid state. That ice, though crystalline in freezing, was probably colloid in melting, that iron, though feebly crystalline while cold, became colloid at a welding heat, and so on. He did not consider these points sufficiently mature for publication, but we discussed them as matters of interest to be kept in view

as the subject of regelation and welding might develop, and I must say I felt strongly inclined to his view. I anticipated that the condition of matter which facilitated welding—using the word in a wide sense, was the reverse of that which is most favourable to, and most characteristic of, crystallisation. My idea of crystalline matter was that the molecules had such polarities as caused their arrangement in a regular crystalline form, and the molecules would have little or no tendency to unite unless presented to one another in the position of this normal arrangement, and that colloid bodies consisted of molecules which cohered together in obedience to polarities which were not selective in their action, but which would cause the molecules to unite and cohere in any position or arrangement; and that welding or cohesion should take place when, by mechanical means, the masses could be brought together as closely as are the molecules within the masses. On this supposition welding should be a general property of such amorphous bodies as are soft enough to admit of their surfaces yielding so as to adapt themselves perfectly to one another. Practically, however, we had only a very limited experience of this till Professor Spring announced the success which he had achieved in uniting a great variety of powders by submitting them to pressures varying up to 20,000 atmospheres. I repeated a number of his experiments, and added others, and have now the pleasure of laying before you a few typical examples of the results. I had intended embodying, in the present address, some account of these experiments, but I find time will not permit me to do so at present, though it is possible I may find another opportunity of giving you a few details.

If we take a comprehensive view of welding, it is evident (without recourse to Professor Spring's experiments) that it accompanies a soft or semi-fluid condition rather than either a crystalline or colloid nature. The running together of two dew drops on the petal of a flower is the same thing in principle as the union of zinc filings under the pressure of 10,000 atmospheres in Professor Spring's apparatus, or the welding of the coils of a 100-ton gun in Sir W. G. Armstrong's works. Solidity and fluidity are but the different parts of an unbroken chain. The dewdrop on a rose retains its rotundity against the force of gravity, in obedience to the greater force of its molecular attractions. On the other hand, the molecular attractions of the metal, great as they are, yield to the greater force of mechanical pressure, and zinc flows under the force of 10,000 atmospheres, or iron welds under the combined forces of the furnace and the forge. The probability is that all things would weld under circumstances such as would make them flow; that is, the molecular forces within the mass must be reduced or the external forces must be increased till the latter are at least equal to the former.

Pharmacists have long been familiar with the welding tendency of powdered camphor, aloes, and other soft bodies of either a crystalline or amorphous nature. I should have felt considerable surprise if there had been a general difficulty in causing the welding of amorphous or colloid bodies, and among the first experiments I tried, after ascertaining that I could readily obtain Professor Spring's general results, were those to determine the welding power of sundry familiar colloids. Gum, sugar, starch, gelatine, resins, and amorphous salts were tried with the general result that amorphous bodies unite in a very similar degree and manner to the crystalline.

Amorphous sugar welds rather more easily and rather more perfectly than crystalline sugar under the same pressure. With crystalline and amorphous chrome alum there was no appreciable difference. The double citrate of ferric oxide and ammonia, though an amorphous salt, unites perfectly and readily; so does the double sulphate of the same bases which is a crystalline alum.

Though I have ceased to believe with Brayley that the colloid condition is an essential preliminary to a good weld, I have not learned to think with Spring that it is less favourable than the crystalline state; a definite judg-

ment upon this point must be reserved for a much more extended evidence.

Professor Spring has obtained several other results no less interesting; he has shown that sulphur, in whatever condition it is put into the press, assumes its densest condition under pressure. Whether amorphous or prismatic in the first instance, it becomes octahedral by compression. Thus pressure is capable of producing molecular change, and the allotropic condition which is possessed of the greatest density. He has also submitted a mixture of copper filings and sulphur to a pressure of 5000 atmospheres, and obtained a block of sulphide of copper, showing that the pressure which suffices to cause the welding together of the particles of sulphur, or the particles of metal if applied to them separately, has the power of facilitating their chemical union if applied to them when mixed, but he thinks that such chemical union only takes place when the resulting compound occupies less space than the two elements in the separate state. In illustration of this I have upon the table a little block obtained by the same treatment of a mixture of sulphur and powdered tin, in which mechanical union and cohesion have been obtained, but not chemical union, the sulphur being still visible with the aid of a lens. There is here a resistance to blending, which we may compare to the immiscibility of oil and water, or to the aqueous solutions of ammonia and carbonate of potash previously noted, a resistance which we may suppose to be due to a want of harmony in the molecular movements of the bodies concerned, a discordance which is not removed by pressure such as we can apply, but which is removed by an increase in temperature. We may suppose the discordance to be similar to that of phosphorus and oxygen in the cold, where the union is retarded by pressure, and expedited by the reduction of pressure, or the increase of temperature. If the molecular movements of two elements in the separate state take place in one plane, the composition of these motions may result in a motion occupying more space, less space, or the same space as that occupied by the sum of the original elementary motions, but if the elementary motions are in different planes the result is a movement occupying more space than the sum of the previous movements. Under these circumstances there is a natural obstacle to this composition of forces, if the elements are brought together in a space too small to allow of the resultant motion. This is probably another way of putting the conclusion at which Professor Spring had arrived, i.e., that combination takes place when the resulting compound has a greater density than the mean of the two elements, and does not take place if the density is less than the mean.

Chemical action is probably the influence or effect of the force exerted by molecules of one nature upon the motions of molecules of a different nature, and having different kinds of movement; the resulting motion determining the nature of the resulting compound, and the action taking place when the differing molecules come in contact, or, if we accept the current theory, that the spaces between the atoms in solid bodies is large in comparison to the size of the atoms, instead of saying when the atoms come in contact, we must say when the ethereal atmospheres which surround them, come in contact. The idea that combination is the result of a harmony of some of these molecular movements is supported by the fact, that mechanical union takes place when powdered sulphur and chloride of potash are powerfully compressed, and that chemical union takes place when they are powerfully rubbed together, the harmony of their molecular motions not being close enough to cause chemical union till the mechanical motion of friction assists, probably by altering one or both of the molecular motions, in such a way as to make them harmonise more closely, or by the mechanical disintegration of particles disturbing the polarities of the simple body, as chemical decomposition effects the nascent state of molecules liberated from chemical union. Friction is said to ignite a match by causing heat. Why not say

it causes chemical action directly? We have no evidence that heat is produced *before* the chemical action, except the general experience that heat is one of the results of friction; and no evidence at all that the chemical action observed is due to the heat produced by the friction. We also know that light and electricity are results of friction, and though light is said to be one of the evidences or consequences of a certain degree of heat, we cannot for a moment admit that light is invariably an evidence of heat, or at least of that degree of heat which is said to be luminous, and when, by rubbing two quartz pebbles they shine in the dark, there is scarcely a possibility that any portion of the stone has been raised to the temperature of incandescence. Again, if, instead of quartz, we take loaf sugar for the experiment, the sugar would not bear a temperature capable of producing light through the development of a luminous heat. It is not more philosophical to say—*friction produces molecular motions of various degrees of intensity, which manifest themselves as heat, light, electricity, or chemical action?* In the friction light of quartz the yellow rays preponderate, while in the friction light of sugar the blue rays preponderate, and both are no doubt accompanied by that lower grade of molecular motion which is known as non-luminous heat, and possibly also by electricity. The odour of the rubbed quartz may be the result of chemical action, though of what nature we have no evidence; it does not resemble ozone, though it might be a silica compound of a parallel nature.

(To be continued.)

NOTICES OF BOOKS.

Manual of Blowpipe Analysis, Qualitative and Quantitative, with a Complete System of Determinative Mineralogy. By H. B. CORNWALL. New York: D. Van Nostrand. London: Trübner and Co.

THE object of the author of this work has been to furnish a complete guide in all branches of blowpipe analysis. To a great extent Prof. Cornwall has followed Plattner, especially, as is stated in the Preface, in Chapters III. and VII., as well as in the Section on Quantitative Blowpipe-work. But there are several distinct features. We find here a chapter on the characteristics of important ores, and a systematic procedure for mineralogical determination, in which the blowpipe is as far as possible employed, to the exclusion of the wet methods. A part of these instructions in determinative mineralogy is taken from the works of Von Kobell and of Naumann. The entire treatise is written not as a manual of reference for the matured chemist, but rather as a class-book for the student. Hence it includes details and repetitions useful to the latter, though to the former unnecessary.

The author begins with directions for self-instruction, based on the supposition that the student is acquainted with the rudiments of inorganic chemistry.

In the first chapter he treats of apparatus, reagents, and operations. Like not a few good authorities, he gives the preference to a blowpipe with a trumpet-shaped mouthpiece. We may here be permitted to say that the choice of a mouthpiece depends very much on the shape of the mouth to which it is to be applied. For persons with thin muscular lips the inverted mouthpiece is preferable; they feel no weariness from prolonged blowing, whilst, on the other hand, they cannot well adapt the lips to a trumpet or bell-shaped aperture. The latter is undoubtedly preferable for persons with full, protrusible lips. The author fully recognises that "the best form of lamp for all general use, and the only trustworthy one for quantitative work, is that of Berzelius." Among supports we find mention only of charcoal, glass tubes, and platinum wire, foil, and spoons. The chapter concludes with general operations in analysis by the moist way.

The second chapter treats of general operations and examinations in qualitative blowpipe analysis, and concludes with Plattner's Table of the behaviour of alkalies, earths, and metallic oxides before the blowpipe.

In the third chapter we find special tests necessary for the elements in special combinations, whilst the fourth gives instructions for the systematic blowpipe examination of unknown substances.

Chapter V. gives, briefly, directions for the detection, in the moist way, of substances most commonly met with under conditions which do not admit of their detection by the blowpipe alone.

The sixth chapter consists of three pages devoted to spectrum analysis.

Chapter VII. treats of the use of the blowpipe in quantitative analysis, with especial notice of silver, gold, copper, lead, bismuth, tin, cobalt and nickel, and mercury. Instructions are also given for the blowpipe assay of iron ores, the iron only being determined, and of coal.

The ninth chapter is devoted to an account of the appearance and characteristic reactions of the more important ores and fuels, whilst the last chapter treats of determinative mineralogy.

There are sixty-nine illustrations, an index to minerals, and a general index, which, as far as we have tested it, appears accurate.

For the purposes for which this work is designed it may be safely recommended, and it is a further proof of the fact that more attention is paid to the blowpipe in America than in England.

Magnetism. By THOMAS P. TREGLOHAN. London: Longmans and Co.

FROM the Preface of this little work we extract two sentences which in substance, though not in wording, we have too often met with:—"This work has been written to supply a want long felt by students who are preparing for examination in the Elementary Stage of the Science and Art Department, so that the subject may be simplified and their studies facilitated by treating it under the divisions laid down in the Syllabus of the Department."

Again:—"The questions at the end will be found useful for examination purposes, and the author would suggest a thorough study and mastery of the principles contained in them."

These two sentences sufficiently show the character of the book. The questions referred to are those which have been set by the Science and Art Department in the years from 1867 to 1882, arranged in chronological order. One of these questions might somewhat amuse the irreverent. "People sometimes say 'the earth is a magnet.' What do they mean?" The answer lies very near: "Often they do not know!"

We are glad to find that this little work follows a more rational procedure than do not a few of its class. Every point is shown to the pupil experimentally, who afterwards reads concerning the meaning and the connection of what he has seen. This is the true way of teaching.

Notes on Chemical Calculations, with Examples. For Use in the Leys School. By A. VINTER, M.A. Batley: J. S. Newsome.

WORKS of this class appear to be increasing in number, and may perhaps become as plentiful as the ordinary chemical manuals. They must always be the despair of the reviewer, since they afford scope neither for praise nor blame.

Pennsylvania Pharmaceutical Association. Proceedings, 1882.

PERHAPS the most interesting part of these Proceedings, from our point of view, is the Report of the Committee on Adulterations. We find mention of "vermillion, free

from mercury but of handsome appearance. It was said to be orange mineral, tinted with eosine." On the list is sodium hyposulphite adulterated with sodium sulphate to the extent of about 28 per cent, and quinine sulphate containing 75 per cent cinchonidine sulphate. Cream of tartar is sophisticated with 14 to 90 per cent of clay, lime, starch, carbonates, and sulphates. Crude gas-tar is sold as crude carbolic acid. Indeed one sample of this article contained no carbolic acid at all, and merely 10 per cent of cresylic acid.

In discussing the question of pharmaceutical education a Dr. Wolff says—"I think it is an outrage to work a man from 5 in the morning until 11 at night." If such are the hours of labour in America we need not wonder at the words of warning which Mr. Herbert Spencer uttered before his return to England.

A paper was read by Mr. Gustavus Pile recommending Beaumé's hydrometer. What advantages this instrument has in comparison with the direct specific-gravity scale or with Twaddle we have never been able to see.

The enactment of further restrictions on the sale of "poisons" is discussed. The Draft Bill contains a proviso that the sale to agriculturists of such articles as are commonly used by them as insecticides is not to be interfered with. This is, so far, rational enough; but why may not the numerous other persons who employ poisons in the arts and manufactures claim a similar privilege? And why should the sale of poisons be restricted more than that of explosives and ammunition?

CORRESPONDENCE.

WATER ANALYSIS.

To the Editor of the Chemical News.

SIR,—A perusal of Mr. Reuben Haines's paper on the above (CHEMICAL NEWS, vol. xlv, p. 237) has called my attention to some laboratory memoranda which, though entombed in my note-book since 1869, may be useful today. The few suggestions I have to make are the following:—

Ammonia-free Water.—I have observed that Manchester water, to which has been added 30 drops or so of sulphuric acid per gallon, yields a distillate that does not give the Nessler reaction on 100 c.c. A large glass retort is used, and only half filled to avoid spitting. As the volume in the retort diminishes it is restored with hot acidified water from another vessel, and the operation continued. The acid retains not only the free ammonia, but also such ammoniacal bases as may arise from a splitting up of nitrogenous matter in the water. A distillate prepared in this way has been found to answer all the requirements of Mr. Wanklyn's process. When the water is intended for air washing by Dr. Angus Smith's methods it should be rendered alkaline with ignited sodic carbonate, and redistilled.

Alkaline Permanganate.—Take rather more of the man- ganic salt than directed. Place in a clean flask, and wash twice by slight agitation with 50 c.c. of water each time. When the washed salt and the potash have been dissolved in the requisite amount of water the solution is boiled in a flask for some time, adding ammonia-free water to supply the loss. Most workers, I believe, adopt the plan of boiling to remove ammonia, though it may not be a general practice to wash the permanganate crystals, or to further boil the measured quantity of the oxidising solution with a little ammonia-free water just before putting it in the retort. I can recommend both these precautions for ensuring the absence of ammonia from the alkaline permanganate, though perhaps some apology is needed for recording them, since they will probably occur to most analysts.

Nessler Solution is conveniently kept in a capped bottle from which the inner stopper is removed. The ground surface of the cap is smeared with soft paraffin. In this arrangement there is no stopper to get hopelessly fixed, or cork to become rotten and fall into the solution. Mr. Haines's remarks on swilling out his retort condenser and trial tubes just before use are quite to the point. A medical pupil in this laboratory, anxious to see his apparatus bright and clean, used a towel, the corner of which he had dexterously inserted to the bottom of each trial tube. This misapplied zeal for cleanliness raises a smile when one reflects on the extreme delicacy of the Nessler reaction, and the condition, both material and chemical, of most laboratory towels. All trial tubes and pipettes, after thorough cleansing with acid and alkali, should be well rinsed under a tap, and finally with distilled water immediately before use. The stem of the retort should be drawn off so as to form a shoulder, on which the black rubber tube connecting it with the condenser is secured by binding with string.—I am, &c.,

PHILIP HOLLAND.

18, Exchange Street, Manchester.

A CORRECTION.

To the Editor of the Chemical News.

SIR,—On page 319 *Proceedings A. A. S.*, Boston (1880) Meeting, are two analyses showing the effect of heating with dilute acids on rotatory power of grape sugar. I desire to add that I omitted to take any account in this experiment of the "birotation" of commercial grape sugar, since at that time I supposed this phenomenon was confined to the crystallised variety. The great loss in rotatory power shown by these two experiments, therefore, is not due to the cause assigned in the paper.—I am, &c.,

H. W. WILEY.

The La Fayette Sugar Refinery,
La Fayette, Ind., November 20, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Chemiker Zeitung.

Vol. vi., No. 50, August 31, 1882.

Notices of Patents.—We find here abstracts of W. Majert's process for the preparation of violet and blue dyes by the oxidation of a mixture of phenols, or para- or meta dihydroxyl derivatives of aromatic hydrocarbons, with the sulpho-acids of aromatic para-di-amines in a neutral solution (German patent, No. 18,628). Also the proposal of Hutinet and Lamy for preparing bromised, iodised, and chlorinised photographic gelatine paper (German patent, 18,794). Also C. H. Foeckner's process for recovering soda from lyes in a manner not to be understood without the accompanying cut (No. 18,493). Also improvements in obtaining green dyes from the tertiary phenyl-amines (No. 18,959), and R. Rickmann's process for obtaining "blanc fixe" (No. 19,073).

Curious Laboratory Explosion.—H. Deibel.—For obtaining an aqueous solution of hydriodic acid, 100 grms. iodine were covered with an equal weight of water, and ordinary phosphorus was added in fragments until the liquid was colourless. The solution was then freed from suspended phosphorus by filtration over asbestos, and was distilled until almost all the hydriodic acid had passed over, and the residue in the retort had become a thick syrup. On removing the flame the retort was filled with white fumes, and an explosion shattered the apparatus.

New Method for Determining the Flashing-Point of Petroleum.—Leo Liebermann.—The author's process cannot be rendered intelligible without the aid of the accompanying illustration.

Incombustible Writing and Printing Paper.—Asbestos of the best quality is treated with potassium permanganate, and then with sulphuric acid. 95 per cent of such asbestos is mixed with 5 per cent of wood pulp in water containing borax and glue. A fire-proof ink is made of platinous chloride and oil of lavender, mixed, for writing with Indian ink and gum, and for printing with lamp-black and varnish.

No. 51, September 7, 1882.

The Schaffner-Helbig Process according to L. Mond.—The author maintains that by his own process from 50 to 60 per cent of the sulphur is recovered by Continental manufacturers, though only from 30 to 33 per cent have been obtained in England. He contends that the residues from the Schaffner-Helbig process are not pure calcium sulphide, and that the final result is not pure calcium carbonate, but a mixture of substances capable of being used as a substitute for limestone in the Leblanc process only to a certain extent. He thinks that a financial comparison of the two processes is for the present premature.

Is the Production of Carbon Dioxide or of Carbon Monoxide promoted by Combustion of Coal at High Temperatures?—Prof. Ledebur.—The author shows that, contrary to the usual opinion, the relative yield of carbonic acid decreases with a rise of temperature, and at 1100° is only 1.3 per cent.

Preparation of Potassium Carbonate from Potassium Chloride.—B. Wittgen and E. Cuno.—Mix concentrated solutions of potassium chloride with zinc oxide, hydroxide, or carbonate, and treat with carbonic acid in closed vessels. Zinc chloride remains in solution, whilst a double potassium-zinc carbonate is deposited, and is decomposed by treatment with hot water, when the solution of potassium carbonate is evaporated down.

Production of Chlorides of the Earthy Alkaline Metals from their Respective Sulphates.—B. Lach.—Whilst reducing heavy spar with carbon, the author passes hydrochloric gas over the ignited mass, obtaining at once barium chloride and sulphuretted hydrogen. The decomposition is said to be more complete and the working temperature lower than in the common process.

Improvements in the Manufacture of Gelatine and Glue.—A. J. Huet treats the animal matter for twenty-four hours with a solution of aluminium chloride at from 3° to 7° Tw., and leaves them in heaps till required. On boiling, the fat collects entirely on the surface, whilst in the common process with milk of lime from 5 to 7 per cent is wasted.

Improved Extraction-Apparatus with Cohobator (German Patent, 18,922).—V. Hänig and O. Reinhardt have devised an apparatus, which cannot be described without the appended diagram.

Combination of the Leblanc and the Ammonia-Soda Process with Simultaneous Recovery of the Sulphur and the Ammonia (German Patent No. 19,216).—Max Schaffner and W. Helbig.—The vat-waste obtained by Leblanc's process is treated with magnesium chloride according to Schaffner and Helbig's method for the recovery of sulphur. Magnesia is obtained. The excess of magnesium chloride is precipitated as magnesia by treatment with burnt lime or dolomite. This magnesia is employed for evolving ammonia from the sal-ammoniac lyes of the ammonia-soda process, reproducing magnesium chloride.

Preparation of Coatings for Protection against Rust.—A. Riegelmann prepares for this purpose alkaline mixtures.

Adulteration of Barium Sulpho-cyanide.—J. Tscherniac.—This compound, though so recently introduced into commerce, is already grossly adulterated. The author recommends to shake up a small quantity of the sample with two or three times its weight of absolute alcohol. The pure salt dissolves rapidly, whilst the impurities remain insoluble.

No. 52, September 10, 1882.

Detection of Strontianite.—Drs. Jehn and Wüsthoff.—A little of the mineral is dissolved in dilute nitric acid in a test-tube, the solution evaporated, and the crystals are treated with a mixture of equal volumes of ether and absolute alcohol. If all is dissolved nothing but calcite was present, but if the salt remains undissolved the sample is strontianite. The evaporation of a drop of the solution upon a watch-glass shows whether calcite is simultaneously present.

New Sewage Process.—A company has been formed at Liege for working the patent of M. Neujeun. This inventor proposes to purify sewage by filtering it through the basic slags of the Bessemer process which contain calcium phosphate. These slags are said to withdraw from the sewage the organic and especially the nitrogenous matter, as well as a part of the mineral impurities, whether dissolved or suspended. The slags are then converted into superphosphate by treatment with sulphuric acid. Analytical confirmation is wanting.

Formation of Nitric and Nitrous Acids.—Dr. S. Kappel.—The author has examined the presence of nitric acid in the solution of copper oxide in ammonia, and finds that the transformation of ammonia into nitric and nitrous acids in presence of copper and oxygen takes place in the cold, but is accelerated by heat. The same acceleration takes place in cold, in a current of carbonic acid. The oxidation of ammonia in presence of copper cannot be shown with certainty in the total absence of air. The copper may be replaced by zinc and iron, but their action is weaker than that of copper.

Formation of Ozone and Hydrogen Peroxide.—Dr. S. Kappel.—The author examines if fixed alkalies in contact with air and copper induce the generation of nitrous acid. He finds that on passing pure air through a pure alkaline solution in contact with copper, ozone and hydrogen peroxide are formed, but scarcely nitrites. These reactions take place in warmth only, and cease in cold weather, thus confirming the supposition that H_2O_2 is an endothermic compound. Metals which in contact with alkalies evolve hydrogen do not produce these formations, as the nascent hydrogen has a reducing action.

Certain Earths present in Cerite.—B. Brauner.—In order to revise the atomic weights and leading properties of the earthy metals contained in cerite, Brauner worked up about 3 kilos. cerite, and obtained 1380 grms. cerium oxide. After its separation the combined oxides were submitted to a long systematic series of fractionated precipitations with ammonia till all the portions more basic than didymium have been removed. The 58 grms. didymium oxide thus obtained were still not homogeneous. By repeated fractionation the last or least basic portion was isolated. By a double precipitation with potassium sulphate there was first obtained an earth of the atomic weight 149.2, or, after correction for a portion of didymium still present, $B''' = 150.7$. By the study of the absorption-spectrum it was shown that this fraction consists chiefly of samarium (or $Y\beta$ of Marignac), but as the atomic weight of $Y\beta$ according to Marignac is $R''' 149.4$, the possibility is not excluded that it occurs here in mixture with a second earth of a higher atomic weight. In the more soluble double sulphates of this fraction the presence of the following metals has been hitherto shown: Yttrium, by its spark spectrum, and erbium and holmium (Soret), by their absorption-spectra. As some portions of this fraction yield orange-coloured oxides the presence of terbium may be suspected. Hence there occur in cerite,

in addition to the earthy metals, cerium, lanthanum, and didymium, at least six other elements of this group.

Non-existence of Pentathionic Acid.—W. Spring.—Already noticed.

Synthesis of Acids, Acetons, Aldehyds, and Glycolic acids in the Aromatic Series.—E. Burcker.—The author by means of the synthetic method of Friedel and Crafts has obtained benzoyl-propionic acid, and benz-hydril-propionic acid.

Chemistry of the Nymphaeaceæ.—W. Grüning.—The author has obtained from the roots of *Nuphar luteum*, a new alkaloid, nupharine, $N_2C_{18}H_{24}O_2$. It is characterised by the following reaction:—If the sulphuric solution of nupharine is allowed to evaporate over sulphuric acid, in ten to twelve days the liquid takes a splendid green colour, which in ten days more passes into a deep greenish blue. If a few drops of water are added the colour immediately disappears, with formation of a yellow crystalline deposit.

Occurrence of Organic Bases in Commercial Amylic Alcohol.—L. Haidinger.—Amylic alcohol, even when sold as pure, generally contains bases, among which pyridine has been identified. This circumstance is of importance in proximate analysis as amylic alcohol is often used for the extraction of alkaloids.

Separation of Antimonic Acid from Antimony Oxide, and of Antimony and Tin.—Dr. A. Zeller.—Only antimonic acid, or the corresponding penta-chloride, has the property when in hydrochloric solution of separating 2 atoms iodine from potassium iodide for every atom of antimony. Stannic acid (or chloride) in an acid solution have no decomposing action upon potassium iodide. In this manner antimony and tin in alloys may be easily separated and determined.

Reactions of the Bile Pigments.—E. Capranica.—If 2 parts of bromine dissolved in 100 parts of alcohol are added by drops to a solution of bilirubine in chloroform or ether, the liquid becomes first emerald-green, then blue, violet, red, yellow, and finally colourless. The action of chloric and iodic acid is similar. The solutions of the yellow cells of the chloroidea and retina, of the yolk pigment, and the corpora lutea, are decolourised at once without a trace of green colouration.

Action of Wine upon Kaolin.—R. Kayser.—A proportion of 0.3 to 0.4 grm. alumina per litre is no proof of the presence of alum, since the acids of the wine may dissolve alumina from kaolin added as a clarifying agent, or from earthy dust adhering to the skins and stalks of the grapes.

New Colour Reactions of the Alkaloids.—Dr. C. Arnold.—(1) Coniine.—If a few drops of syrupy phosphoric acid are mixed with a drop of coniine, and the mixture is evaporated over a small flame in a white porcelain capsule, the mixture takes a fine green colour. (2) Nicotine, treated in the same manner, gives a deep yellow or orange colour. (3) Aconitine.—The known violet colour, on evaporating this base with phosphoric acid, is best obtained if a few particles are stirred up with some drops of syrupy phosphoric acid and heated for ten to fifteen minutes on the water-bath.

Cosmos Les Mondes.

No. 7, October 14, 1882.

Vanadium Green.—According to MM. Osmont and Witz, vanadic acid, on treatment with hydrochloric acid, gives a fine green colour, which may be at once employed in dyeing.

No. 8, October 21, 1882.

Nickel is proposed in France as a substitute for bronze in coinage. To prevent them from being mistaken for silver the pieces will be octagonal instead of round.

Properties of Antiseptics and the Volatile Products of Putrefaction.—G. Le Bon.—The disinfecting power of an antiseptic is so much the less as the putrefaction is of less recent origin. There is no parallelism between the disinfecting power of an antiseptic and its action upon microbia. Potassium permanganate, which is one of the most powerful disinfectants, has no appreciable action upon microbia. With alcohol the case is reversed. There is no parallelism between the power of hindering the production of putrefaction and that of arresting it when it has taken its rise. Alcohol and phenol, which are excellent preservatives, have but a very feeble action upon putrefaction when it is established. With the exception of a small number of formidable poisons, such as mercuric chloride, most of the antiseptics, and especially phenol, have little action on bacteria. There is no parallelism between the virulent power of a body in putrefaction and the toxic power of the volatile compounds which it gives off. These two properties even seem to bear an inverse relation to each other. The quantity of the products of advanced putrefaction necessary to kill an animal by simple admixture with the air which it breathes is very small, and proves that these volatile alkaloids are extremely poisonous. Hence the atmosphere of cemeteries may be extremely dangerous notwithstanding its poverty in microbia.

Silico-molybdates.—F. Parmentier.—The author has obtained a silico-molybdic acid by adding to an acid solution of a molybdate dialysed silica, or a silicate dissolved in an acid. The free acid is obtained by treating mercurous silico-molybdate, suspended in water with dilute hydrochloric acid.

Rotatory Power of Tyrosine and Cystine.—Dr. J. Mauthet.—These two bodies are sinistro-rotatory, tyrosine feebly, but cystine energetically.

Justus Liebig's Annalen der Chemie,
Band 215, Heft 1.

Synthesis of Pyridinoid Compounds from Acetic Ether and Aldehyd Ammonia.—Dr. A. Hantzsch.—A voluminous memoir, in which the author describes the preparation and properties of hydro-collidine dicarbonic ether; its halogen derivatives; its oxidation-product and its derivatives; the decomposition-products arising from the action of hydrochloric acid upon hydro-collidine dicarbonic ether, and finally the oxidation-products of collidine dicarbonic acid.

Communications from the Laboratory of Prof. V. Meyer, of Zurich.—These consist of Contributions to the Knowledge of the Fluoresceine Reaction, by Dr. E. Knecht, and a treatise by Dr. C. Langer on Uniformities in the Substitution of the Aromatic Amines.

Band 215, Heft 2.

Contributions to the Knowledge of the Quinones and Hydro-quinones.—R. Nietzki.—The author describes the preparation of quinone and hydro-quinone, the combinations of the quinones with the phenols and with phenoloid bodies, the nitro-derivatives of quinone and hydro-quinones, nitranilic acid, di-nitro-hydro-quinone, the nitro-derivatives of di-ethyl-hydro-quinone, toluquinone, hydro-toluquinone, its methyl-ethers and their condensation-products, xylo-quinone, and hydro-xylo-quinone.

MISCELLANEOUS.

The Bread Reform League.—Our attention has been called to the above movement, which, it appears, enjoys the countenance of some of the first chemists and physiologists of the day. Its object is to bring into general use bread made from the entire grain of wheat, instead of

from its inner portion only. Such a change, it is contended, would not only effect a saving of from 20 to 25 per cent of the money expended in the purchase of grain, but would be decidedly beneficial to health. It seems to us that the question is deserving of further investigation both chemical and physiological. Experiments on the comparative nutrient power of white bread and wheat-meal bread would, if made upon animals, probably expose the unfortunate investigator to the pains and penalties of the "Vivisection Act." But any man who can obtain the whole-meal bread—"grund-down" as it used to be called in the North—is at liberty to experiment upon himself. It is certain that such bread is a very different article from the brown bread commonly sold.

NOTES AND QUERIES.

* Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertising columns.

Fish Offal.—Will you kindly tell me what is the average chemical composition of fish offal, i.e., heads and guts, when separated from the bodies? or name a good work on this subject?—F. G.

Specific Heats.—Would the abstractor of the proceedings of the Russian Chemical Society kindly inform me what numbers M. Diaconoff obtained for the specific heats and heats of vapourisation of normal propyl alcohol, amyl alcohol, and dimethyl-ethyl carbinol?—W. RAMSAY.

MEETINGS FOR THE WEEK.

SATURDAY, 9th.—Physical, 3.

MONDAY, 11th.—Medical, 8.30.

London Institution, 5.

Society of Arts, 8. "Dynamo-electric Machinery," by Prof. Sylvanus P. Thompson, D.Sc.

TUESDAY, 12th.—Institution of Civil Engineers, 8.

Royal Medical and Chirurgical, 8.

Photographic, 8.

WEDNESDAY, 13th.—Society of Arts, 8. "Electrical Exhibitions," by W. H. Preece, F.R.S.

Microscopical, 8.

THURSDAY, 14th.—Royal, 4.30.

Philosophical Club, 6.30.

London Institution, 7.

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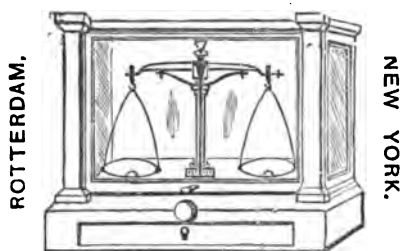
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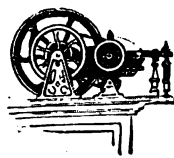
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THE CHEMICAL NEWS.

VOL. XLVI. No. 2303 16 82

ON THE COMPARATIVE EFFECTS OF TWO METAMERIC BODIES ON THE GROWTH OF *NICOTIANA LONGIFLORA*.

By J. EMERSON REYNOLDS, M.D., F.R.S.,
Professor of Chemistry, University of Dublin.

THE study of the comparative action of metamerie compounds on the growth of plants seems to deserve more attention than it has yet received from chemists and vegetable physiologists, and the aim of the communication I now beg to lay before the Academy is to show that well-marked differences in physiological activity can be detected with the aid of plants, even in cases of metamerie bodies of comparatively simple constitution.

The bodies selected for experiment were ammonium sulphocyanate and its metamer thiocarbamide, or sulphurea. Both compounds are rich in nitrogen, and therefore capable of supplying a highly important element of plant-food; they are easily soluble in water, and, consequently, admit of absorption through the roots of plants; moreover, their chemical relations have been carefully studied, and their differences of structure are known; hence they seemed to be very suitable for the class of work in which I proposed to employ them.

The sulphocyanate is a true ammonium salt of sulphocyanic acid, and its composition is represented by the formula—



The metamer of this body, or thiocarbamide, I discovered in 1860, and obtained in the following way:—

The salt was melted, and the temperature of the liquid raised to 170° C., when rearrangement of the components of the molecule took place; the mass, when cooled, extracted by water and crystallised, afforded fine crystals of thiocarbamide. This body contains the same elements as the sulphocyanate, and in the same proportions, and its molecular weight is the same; but its relations and chemical structure are very different, as it is a feeble base, and destitute of saline characters, while its relations are represented by the structural formula—



During the summer of 1881 I made several sets of experiments with these bodies on selected groups of plants which are known to afford special nitrogenised or sulphuretted products, when grown under normal conditions. Some of the results obtained are sufficiently definite to justify their publication, while others require repetition under new conditions. In the present communication I shall confine myself to the statement of experiments made with a variety of the tobacco plant (*Nicotiana longiflora*). The seeds were obtained from Messrs. Veitch and Sons, and afforded a good crop of young plants, which were removed from the seed-bed, and potted singly in very sandy mountain loam, of rather poor quality, the aim being to give the plants no more nourishment than was absolutely necessary to ensure moderate development. When the plants were shifted into four-inch pots they were allowed to become thoroughly established, and the experiments commenced.

Several sets of three healthy plants were picked out, and the members of each set were as nearly as possible in the same stage of development, i.e., they were of the same height, had an equal number of leaves, and equally strong

stems. Each set was subjected to the same treatment, but it will conduce to clearness if I trace that of a single set.

The treatment pursued was the following:—

No. 1 was watered with Vartry water only, when necessary.

No. 2 was watered twice each week with a solution of 0.5 grm. of pure thiocarbamide in 250 c.c. of water; at other times it was treated as No. 1.

No. 3 was watered twice each week (unless otherwise stated) with a solution of 0.5 grm. of pure ammonium sulphocyanate in 250 c.c. of water.

The plants were under glass, but so placed as to get equal light, and to prevent any undue tendency to drawing up or "spindling."

The first to show any effects was No. 3 (i.e., that treated with the sulphocyanate); at the third treatment with the solution the growth was checked, and the plant seemed not only to stop development, but even to shrink in a curious way: the leaves began to droop, and became rather sickly in colour. The fourth application only intensified the symptoms of plant-poisoning by the sulphocyanate; hence the treatment was stopped, and the soil well washed out by percolation of pure water. After this the plant recovered somewhat, and re-commenced growth; but it received another dose, which again checked development. Washing the soil was repeated, and another rest allowed. This treatment was continued for nearly three months, up to the 1st of December, when it presented a very miserable appearance, and was in the condition stated in the Table. This plant was then removed from the soil and dried.

There is no doubt that I could have killed this plant at any time by continued doses of the sulphocyanate, for corresponding plants of other sets so treated with the salt were destroyed in a few weeks.

No. 2 plant (i.e., that treated with the solution of thiocarbamide) soon gave evidence that it felt the effect of its dose, but the result was very different from that observed in No. 3: the stem did not elongate much, but the leaves rapidly developed in length, breadth, and substance, and assumed a healthy deep green hue. It was noticed, however, that the development was less satisfactory where the solution of thiocarbamide was alone used for watering than where there was a washing of the soil with pure water between two doses; in the former case the edges of the lower leaves becoming discoloured and thin. The reason for this is not far to seek, for the thiocarbamide is known to undergo partial re-conversion into sulphocyanate in aqueous solution, and more especially in presence of such decomposable bodies as are found in the soil. The check in development of the plant doubtless followed this partial reversion.

With the slight modification in the treatment just referred to the plant developed remarkably, until, on the 1st December, it was in the state described below.

No. 1 plant (i.e., that treated with plain water) grew rapidly, and soon outstripped the others in height, but its stem and leaves were poor and thin as compared with No. 2.

The following table contains the measurements, &c., of the plants on the 1st of December:—

	No. 1 (Water).	No. 2 (Thio- carbamide).	No. 3 (Sulpho- cyanate).
Total height in inches from surface of soil	31	23	12
Number of leaves	15	14	13
Maximum length of leaf in inches	9½	15½	8
Maximum breadth of leaf in inches	4½	6	2½
Number of seed pods in different stages of development	9	15	none
Number of seed pods well developed	1	11	none

* Read before the Royal Academy, April 10, 1882; and reprinted from the *Proceedings*, 2nd series, vol. iii. (Science), No. 9, December, 1882. Communicated by the Author.

Corresponding results were obtained with the other sets of tobacco plants.

The next step would obviously be the determination of the relative proportions of nicotine derivable from the plants, but the amount of material at my disposal proved insufficient for the purpose. I hope, however, to be able to grow a considerable quantity during the ensuing summer, and to repeat the experiments.

The facts ascertained are, however, amply sufficient to prove that ammonium sulphocyanate acts as a powerful poison on these plants, notwithstanding the large proportion of ready-formed ammonia it contains, while its metameric thiocarbamide stimulates the growth of similar plants, and induces healthy development of all their parts, thus acting as a distinct plant food. Indeed, if it were not that thiocarbamide tends to revert to the sulphocyanate after some time, the former might be regarded as a good organic manure for tobacco.

I must leave to the vegetable physiologist the task of determining the precise way in which nutrition is arrested by the sulphocyanate and promoted by thiocarbamide: for the present I am content to have shown that their effects on the particular plants employed are widely different, though the bodies compared contain the same elements chemically united, in the same proportions within molecules of the same weight. The conclusion is inevitable that their strongly contrasted physiological action is due to diverse molecular structure. We thus learn—

1st.—That the particular elements of which the bodies are composed exerted less influence on their physiological activity than the intra-molecular grouping of the component atoms.

2nd.—That, in some instances at least, differences of physiological activity between metameric bodies can be easily detected with the aid of plants.

ESTIMATION OF SULPHUR IN IRON AND STEEL.

By GEORGE CRAIG.

IN Mr. Rocholl's criticism on my communication on the above subject (CHEMICAL NEWS, vol. xlvii., p. 236) he unjustly ridicules the process I employed to detect sulphur in the residues—because I did not find any—and negatives my conclusion that even cupriferrous irons may be made to yield all their sulphur on treatment with hydrochloric acid—because he cannot get it all off. Unscientific reasoning like that needs no comment.

Now it would be a pity were the oxidation processes (by which I believe the bulk of the sulphur determinations are made) incapable of estimating, according to Mr. Rocholl's experiments, sulphur varying from 0.004 per cent to 0.37 per cent (or 0.04 per cent to 0.27 per cent BaSO_4)—the latter is about the amount obtained from good pig-iron; and the smaller quantity, which from its insignificance could be practically ignored, can easily be estimated in solutions containing such large quantities of KCl and FeCl_3 as Mr. Rocholl states (evidently he has never tried it) would certainly prevent the precipitation of either. All I need say on this point is that if sufficient of a dilute solution of Epsom salts, to contain 0.004 per cent S or even 0.002, be added to such a solution of iron along with a little BaCl_2 , and after standing for twelve hours, on gently rotating the contents of the flask a small precipitate of BaSO_4 will gather at the vortex, and if weighed will be almost the same as that obtained from a similar quantity of the solution of Epsom salts. The chief, if not the only, constituent in such a solution which exerts an interfering action on the precipitation is, I believe, the amount of free acid present.

In a few of the residues from the evolution process I did obtain, after standing forty-eight hours, minute precipitates

which would not give any more than 0.002 per cent sulphur, and the only one I thought worth while estimating was that from a siliceous iron, noticed in my communication to CHEMICAL NEWS, and which only weighed 0.5 grain. As I only obtained these precipitates occasionally, and being so minute I considered they might be attributable to a variety of causes—temporary impurity of the gas used for evaporation, presence of a little SO_2 or H_2S in the laboratory atmosphere—and as it was of no practical consequence whether they belonged to the iron under examination or not, I ignored them. In support of my conclusion that all the sulphur may be evolved on treatment with HCl, and to give recent experiments only, performed since reading Mr. Rocholl's criticism, I made a cupriferrous iron containing 0.50 per cent copper, three determinations of sulphur in 100 grains of which by the (H_2O_2) evolution process gave BaSO_4 0.52, 0.54, and 0.53 grain.

The residues were filtered, excess of KClO_3 (50 grains) added to filtrate, and evaporated with a little additional HCl to prevent the precipitation of basic iron salts, till about to solidify, diluted, filtered, made up to about 20 ozs., BaCl_2 added, and after standing twenty-four hours there was no precipitate in any of them.

The insoluble portion of the residue from the experiment yielding 0.52 BaSO_4 was washed into a basin, and to another basin was added an equal quantity of water, and both evaporated over contiguous argands to dryness; $\frac{1}{2}$ oz. HNO_3 added to each evaporated almost to dryness; $\frac{1}{2}$ oz. HCl added to each, and again evaporated almost to dryness. The evaporations were performed almost simultaneously, and occupied the same time, so that the contents of each basin had the same chance of absorbing sulphur compounds from the burnt gas of the argands or from the laboratory atmosphere. A little water was added to each, heated, filtered, and made up to 4 ozs., BaCl_2 added, and after standing twelve hours, the precipitates, which apparently were about equal, were filtered, washed, ignited, and weighed. That from the residue, which was slightly reddish from containing a little Fe_2O_3 , weighed 0.045 grain, while the blank experiment gave 0.040 grain. This, which would indicate not even a trace of sulphur in the residue, is the method employed by Mr. Rocholl himself, and by which he gets precipitates varying from 0.04 to 0.27 per cent.

The insoluble portions of the residues from the other two experiments were each with their containing filters thrust into a deep platinum crucible, 50 grains KNO_3 and 30 grains Na_2CO_3 added, and the moist mass mixed well with a glass rod, dried in water-bath detached from crucible, which was heated in a small chimney (to prevent access of the products of combustion to the contents of the crucible) to redness over the blowpipe, and the mixture injected in convenient quantities at a time and completely fused, the operation occupying about three minutes; the contents of the crucibles dissolved in water, acidified slightly with HCl, and evaporated gently to dryness, a few drops HCl added, heated with a little water, filtered up to 5 ozs., and BaCl_2 added.

A filter, washed with dilute HCl, was subjected to identically the same treatment; and after the three solutions had stood overnight, the small precipitates (those from the residues being apparently the larger) were filtered, &c. The BaSO_4 from the residues weighed respectively 0.030 and 0.040 grain, while from the blank experiment it weighed 0.015 grain.

This would yield 0.002 and 0.003 per cent sulphur, and these precipitates were brownish from containing a little Fe_2O_3 , and should be manifestly a little less. I fused the combined precipitates with a grain of Na_2CO_3 in the crucible in which they were ignited, decomposed with a drop or two of HCl heated, diluted to 1 oz. bulk, added a drop of BaCl_2 , and filtered after standing six hours, when they weighed 0.05, which after proportioning and deducting blank experiment gives about 0.001 and 0.002 per cent S, which is of no consequence, as is also the larger num-

bers obtained from the impure precipitates. It would seem as if this small amount of sulphur was not in combination with the copper at all (else I should have obtained it by Mr. Rocholl's method), but probably in some way with the carbon.

Tabulating these results give:—

	Cu in Pig-iron.	S evolved.	Sulphur in Residue.		Prcntge. of S evolved.
			Liquid.	Solid.	
I.	0.50	0.063	nil	nil*	100.0
II.	do.	0.065	nil	maxim. 0.002†	97.0
III.	do.	0.064	nil	do. 0.003†	95.4

* Mr. Rocholl's process.

† Fusion process.

Surely there must be some radical difference in the manner in which Mr. Rocholl and myself work the details of the evolution process when we obtain such diverse results, the one getting often only 50 per cent of the sulphur and the other practically 100 per cent. On reading over my communication as it appeared in the *CHEMICAL NEWS* I notice one point that I did not give due prominence to, and which may account for the above difference, and that is the length of time during which the solution is gently boiled after the evolution of gas has become sluggish: I give it from fifteen to twenty minutes.

The composition of the pig-iron has nothing to do with it, as I have tested Middlesbrough brands by the process, also Bessemer irons and white irons containing 0.5 p.c. S, the residue from the latter being absolutely free from even traces of sulphur when tested by the oxidation process described. With steels the process works even better than with pig-iron; and the only case I have met with in which the sulphur could not be estimated by it was that of a siliceous spiegel containing 20 per cent manganese and 10 per cent of silicon.

Lugar Iron Works, Dec. 4, 1882.

PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, late R.A.

(Continued from page 249.)

VI. ON THE USE OF BORIC ACID AS A REAGENT.

(Continued.)

Detection of Alumina by means of Lime.—Another secondary result, of still greater importance than the gelatinisation of aluminoid alkaline silicates (previously described), is shown by the following experiment:—

If we add the powder of a calcium silicate containing no alumina, such as *Wollastonite*, to boric acid under O.P., we obtain a bead transparent or translucent according to the proportion of combined water in the mineral, which causes a kind of grey opalescence on cooling, the bead being perfectly clear hot. Through this semi-opalescent matter are distinctly observed, by means of one of the American lenses now sold in London for a shilling,—(a) transparent balls of calcium borate, but covered with curious, apparently crystalline, marks. (Calcium silicate: about two years ago I discovered by means of a powerful microscope, then first applied to these reactions, that these "marks" were in reality transparent *inner* balls, to be described hereafter). These calcium borate balls are generally a pale green colour when cold (easily observed on account of the semi-opalescent matter round them) due to iron protoxide, from the trace of iron present (0.40, Stromeyer), which is *invariably* seized upon and dissolved by the calcium borate; a large proportion of iron oxide being shown by separate brown-black opaque balls. (b) Free silica, in the shape of semi-transparent, sharp, unattacked fragments. These, and all pyrological contents of boric acid, can be boiled out of the bead and obtained on a filter for weighing.

Now let us add the powder of another calcium silicate,

but containing alumina, such as *Zoisite*, to a fresh boric acid bead under O.P. How different is the result obtained! The bead is, almost immediately, milk-white and quite opaque, just like a little bit of the white enamel used by jewellers. I at once suspected that this must be due to the decomposition by the alumina of the transparent calcium borate balls, and the precipitation and diffusion of the white finely-divided lime throughout the bead. This was proved to be the case by the careful solution of alumina to opaque saturation in a boric acid bead, by means of the addition of carbonate of potassium O.P., when only a *grey* opaque bead was procured. The fact was also confirmed by application of the microscope, when the balls were preserved and seen in the very act of decomposition. Thus, the smallest trace of alumina present in an aluminous silicate may be detected by simply adding to the boric acid bead containing it, a *proportionate quantity* of lime-powder before the blowpipe, when the calcium borate balls are at once decomposed by the alumina, and "miliness" ensues.

To those chemists and pyrologists who know the inefficiency of Gahn's (very beautiful) blowpipe test for alumina by means of cobalt solution, which is absolutely useless when metallic oxides are present, this delicate reaction, by which 0.005 of combined alumina can be detected, must prove a real boon: at all events, Mr. Wanklyn, to whom I showed the above experiment some three years since, thinks so.

For instance, in the case of the "transparent, ice-like mass or jelly" given by the treatment of "zeolite" powder in boric acid, as above described, we have but to add to the bead under O.P. a trace of lime-powder to see (by the "miliness" produced) if only a trace of alumina is present: more lime produces more miliness, and so on, until we find, by the quantity of lime added, precisely the quantity of alumina present. The same phenomenon happens if the alumina is previously present in the boric acid bead in the shape of white opaque fragments, whether combined with silica or not, but apparently (for I am not clear on the subject yet) alumina added to a boric acid bead *after* lime is in possession of its borate has no effect in decomposing it. If there is no alumina in the assay, the added lime is *transparently* dissolved by the alkali present.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 7, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—
G. Chandra Basu, W. R. Flett, E. C. Gill, J. Hunter, T. Jenner, W. W. J. Nicol, F. W. Richardson, E. S. Spencer, C. A. Serre.

During the evening a ballot was held and the Scrutators, Messrs. Greenaway and Kingzett, declared the following gentlemen to be duly elected Fellows of the Society:—J. S. Bishop, E. E. Berry, F. W. Bransom, R. Blair, T. R. Cowie, R. Carruthers, R. Coulthard, W. J. Chrystal, E. G. Clayton, J. T. Dunn, H. L. Dampier, A. G. Earl, G. Gray, A. G. Howard, W. A. L. Hammersley, J. L. Howe, H. Hotblack, A. E. Johnson, E. Jackson, A. Keen, J. Kilner, J. D. McCarthy, H. C. Newton, S. C. Phillips, R. H. Parker, T. F. Peppe, S. Rideal, G. M. Taylor, T. E. Vasey.

The two following papers were read by the SECRETARY:—
"On the Condensation-Products of *Ænanthol*," by W. H. PERKIN, Junr. Much work has been already done on the condensation-products of iso-butyric, iso-valeric, and cœnanthyl aldehyds, but in many cases only the formulæ of the products obtained have been given: the author

majority of cases in which aldehyds enter into reaction with other bodies, the radicle CHR of the aldehyd remains intact, the argument from analogy would lead us to prefer the symmetrical rather than the unsymmetrical formula adopted by Dr. Japp. The formation of benzamide and dibenzamide on the oxidation of lophin, it was pointed out, is not difficult to explain, and the production of benzoic acid on heating lophin with hydriodic and hydrochloric acids is probably a consequence of a purely hydrolytic action. Incidentally Dr. Armstrong objected to Dr. Japp's use of the term "intra-molecular change" in cases involving no transposition of atoms.

Dr. JAPP briefly replied to the criticisms of Dr. Armstrong, and reiterated his conviction that the formula proposed by him agreed best with the known decompositions, &c., of lophin, and he failed to see how Radziszewski's formula accounted for some of the known reactions of that body.

Mr. S. U. PICKERING then read a paper "*On the Constitution of Molecular Compounds: The Molecular Weight of Basic Ferric Sulphate.*" Two methods of notation are commonly employed to represent basic compounds. Thus, with ferric sulphate, $2\text{Fe}_2\text{O}_3\text{SO}_3$, or $\text{Fe}_2(\text{SO}_4)_3$. In this latter an analogy between a basic salt and a hydrated salt is hinted at. If the first formula is correct, the molecular weight is 400; if the latter, m.w. = 1200. The author has in the present paper endeavoured to determine the molecular weight of basic ferric sulphate by ascertaining the unit of water removable from a hydrated specimen of it. The author gives details as to the preparation of the sulphate, the hydration of it, and the loss of water under different conditions. If the molecular weight be 1200, 33 different hydrates are possible. He obtained 14 hydrates, all of which indicate the number 1200, and he concludes that it is practically a certainty that the molecular weight of basic ferric sulphate is 1200, and its formula $\text{Fe}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$.

Mr. TOMS then read a paper "*On the Chemistry of Hay and 'Ensilage.'*" The author has analysed various samples of hay, and contrasted them with analyses of "ensilage," i.e., grass buried whilst green in a water-tight pit or "silo," and subjected to pressure. It is well-known to chemists that hay-making is not a mere drying of grass, but that a fermentation also takes place, which develops the well known perfume of hay, and during which the grass loses its green colour. A specimen of good hay dried contained—

Fatty matters	..	..	..	2.17
Free acetic acid	..	..	..	1.89
Sugar	..	..	..	3.42
Starch	..	..	..	12.46
Gum and mucilage	..	..	..	27.25

A specimen of brown hay from the same rick as the last, but from a portion of the stack which had heated, contained—

Fatty matters	..	..	..	4.26
Aldehyd which formed a mirror with ammonio-silver nitrate	} trace			
Free acetic acid	..	..	..	5.38
Sugar	..	..	..	6.94
Starch	..	..	..	3.42
Gum and mucilage	..	..	..	24.77

More than two-thirds of the starch had thus disappeared, and apparently had been converted into sugar, &c. Three specimens of ensilage were examined. One differed very little from ordinary grass. The second was brown, and smelt strongly of tobacco: it contained more acetic acid and sugar, but less starch. The third specimen represented fodder which had been buried eighteen months: it still contains starch-sugar, but was not acid, and was mouldy.

Mr. O'SULLIVAN did not think that the author had proved the presence of starch in the hay and ensilage, because other substances, such as gum and mucilage, when

boiled with dilute sulphuric acid, furnished cupric oxide reducing substances.

Dr. GILBERT said during his recent visit to America he had heard a good deal about "ensilage," and the process seemed to be thought much of in that country. The crops, too, of succulent maize, &c., seemed well suited for it. It was essential for a good result to put all the materials as quickly as possible in the "silo," and put on a pressure of 100 to 150 lbs. per square foot almost immediately. He suggested that unless samples of ensilage taken for analysis were kept under pressure during transit the product might be completely changed. The process was very suitable for the preservation of the pulp from the sugar-beet.

The SECRETARY then read a paper "*On certain Brominated Carbon Compounds obtained in the Manufacture of Bromine,*" by S. DYSON. The author has separated from a liquor obtained as a by-product at the North British Chemical Company's Works, carbon tetrabromide, bromoform, and chloro-bromoform. These substances were identified by analysis, boiling point, and vapour-density determinations.

Mr. W. H. PERKIN then read a "*Note on the Preparation of Diphenylene Ketone Ether.*" A quantity of salicylic acid was heated with acetic anhydride, the mixture was boiled, and the excess of acetic anhydride distilled off. The residue, consisting chiefly of salicylide, was distilled, and an oily product came over, which solidified to a crystalline mass. On purification pale yellow needles were obtained, having the composition $\text{C}_{13}\text{H}_8\text{O}_2$, fusing at 170° . The yield is 30 to 40 per cent. The author's son, Mr. A. G. Perkin, is engaged in a study of the derivatives, &c., of this substance.

The Society then adjourned to December 21st.

ROYAL INSTITUTION OF GREAT BRITAIN. *General Monthly Meeting, Monday, December 4, 1882.*

GEORGE BUSK, Esq., F.R.S., Treasurer and Vice-President, in the Chair

ACHESON GEORGE BARTLEY, M.D., M.A., David Edward Hughes, F.R.S., George Law, F.R.G.S., F.Z.S., were elected members of the Royal Institution.

Five candidates for membership were proposed for election.

The presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY.

General Meeting, October 26, 1882.

Mr. JOHN PATTINSON in the Chair.

Mr. B. S. Proctor's Inaugural Address.

(Concluded from p. 265).

ASSUMING that all bodies are endowed with molecular movements, and that their disposition to unite depends upon the harmony of these movements, we may naturally conclude that chemical change will be facilitated by change of temperature. It has been a common saying that heat was promotive of chemical change, but that is a one-sided statement, true only in relation to certain degrees of heat. If we were inhabitants of the sun, or some other very hot place, we might note that chemical action was promoted by a reduction of temperature, and that few combinations could be produced without it. The fact is, while a low temperature usually adds to the stability of a compound, when once formed, a high heat prevents the majority of combinations taking place. The aqueous zone—that is, the temperature between the freezing- and boiling-points

of water—is the fertile land of chemical change; here combinations and decompositions in infinite variety take place.

It being admitted that the contact of one body will communicate to others of a different temperature some of its molecular movements,—that harmony of these movements causes combination, and want of harmony causes separation,—it is not unnatural that the presence of one body may cause sympathetic vibration in another of the same temperature, but of different normal velocity of vibration, and thus bring about combination or decomposition in the manner long known as catalysis. The surface action of charcoal and spongy platinum affecting the union of H and O is probably of this nature, and the reverse of the way heat effects the same. The latter increasing the molecular movements till they come into harmony, the former retarding them till another harmony, a different chord, produces a like result. The doctrine of catalysis is going out of favour. Fermentation was formerly spoken of as a catalytic process,—then it was attributed to the force of vegetable life; but to call it vital force instead of catalytic is only moving the difficulty from one place to another, not getting rid of it. There is too much disposition to get difficulties put a little further away, just out of sight for the time being, and then neglecting them; such, for instance, as the recent endeavour to explain the process of digestion by saying that solution of the food in the stomach is principally due to the action of the living vibrios which always abound under these circumstances, and omitting to explain at the same time what aids the digestion in the stomachs of the vibrios; perhaps they have no stomachs, so the difficulty of explaining their digestion disappears. There are, however, a number of cases in which the presence of one body affects the chemical action of another, where we have not the opportunity of hiding our ignorance under the statement that the phenomena are due to vital force:—The decomposition of peroxide of hydrogen by oxide of silver; the more ready decomposition of chlorate of potash when mixed with oxide of manganese; the decomposition of chlorate of silver into chloride and oxygen by the action of nitric acid; the increased explosiveness of fire-damp in the presence of non-combustible dust, such as calcined magnesia; the solubility of platinum in nitric acid, if first alloyed with a large proportion of silver; and many other cases which will readily occur to you. In some of these there is probably no explanation more ready or more rational than the supposition that the contact of one body influences the motions of the others, and by this means influences their tendencies to combine or separate.

Johnstone Stoney, in the *Philosophical Magazine*, vol. 36, p. 134, estimates the velocity of the oxygen molecules. The pressure of the gas on its containing vessel equals its weight multiplied by the velocity of its molecules. He goes on to say if oxygen be replaced by hydrogen, which has only $\frac{1}{8}$ of the weight under the same pressure, the velocity must be square 16 ($16^{\frac{1}{2}}$) times as great, that is 250 to 1, to account for the same pressure. Feeling conscious of my own deficiency in mathematical training and experience, it is with some hesitation that I criticise this latter statement. If the momentum of O equals 16, that of H at the same velocity equals 1. At 4 times the velocity it equals 4 for each impact; but at 4 times the velocity it makes 4 times the number of impacts in an equal time, and so brings up the resultant force to 16. The force being proportionate to the square root of the velocity instead of the square. This velocity is that of the molecule through space from one part of the vessel to another, however small the movement may be, but the internal molecular movements are more regular and minute, and more ready to act upon the waves of light, causing bright spectral lines or absorption lines. The regularity of the motion is shown by the narrowness of the spectrum lines; and the complexity of the motion, by the number of lines belonging to any gas, by how many different velocities of undulations are interfered with, and how sharply the interference is

limited. He quotes Maxwell to the effect that the free path of a molecule of air equals 7 "eighth metres." That is, a molecule of air between its collisions, moves on the average $\frac{7}{8}$ (7—one hundred millionths) of a metre, that is $\frac{1}{16}$ th of the wave-length of the ray D.

The molecule is deflected 7×10^8 (seven thousand million times) in a second, and each free path lasts $\frac{1}{14}$ (fourteen thousand millionths) of a second. This is 50,000 times the double vibration of a red ray, and 100,000 times the double vibration of a violet ray. All the molecular motions affecting light must, Stoney says, vary in velocity only between these limits.

Clausius estimates that the mean distance between the molecules of a gas equal about $\frac{1}{10}$ of the length of their free path. Stoney concludes from Maxwell's experiments that the normal distance is probably about $\frac{1}{10}$ (one thousand millionth of a) metre, consequently there are about 1000 (a trillion) molecules in a cubic m.m. of gas. These statements, and such as these, may be regarded as knowledge in the nascent state, knowledge which scarcely yet exists, but which is to be. We have been taught that heat is a greater promoter of chemical change, but the greater part of the chemical processes with which we are acquainted can only take place at moderate temperatures, that is between the freezing and the boiling-points of water. The vital zone of temperature bears a luxurious growth of chemicals. The zone higher is characterised by decomposition and dissociation, the lower zone by stability of compounds, and the formation of some which are easily decomposed by heat.

In physical conditions also the middle or liquid state is the zone of chemical activity: it is here that molecular movements are sufficiently adive to facilitate change, and yet kept within the bounds in which the motions of heterogeneous atoms have a probable chance of harmonising.

Hardness is a physical obstacle to the act of combination in solids, elasticity equally so in the case of gases, though neither of these objects are insuperable. Increased temperature (and consequent increased elasticity) facilitates the combination of some gases, probably by bringing their molecular movements into harmony with one another. If an equal number of vibrations per second be added to the motions of two inharmonious musical strings, a point may be reached at which they harmonise. If one string vibrates 45 times, while the other vibrates 95, they will produce a discord, but if we add five vibrations to each, making 50 and 100 respectively, the one will sound the octave above the other. An analogous action may enable the movements of two uncombined gases to become so harmonious as to result in their union. The compound motion resulting would then be constant in its character, unless the action of heat be increased so much that dissociation ensues, which would take place if the motion of one of the atoms was acted on by a rhythmical heat vibration, which would so far enlarge its orbit as to set it flying off from its companion atom.

The harmony of vibration may be brought about by other agencies than heat or light, such as pressure; increased pressure tending to combine sulphur and copper—reduced pressure facilitating the union of oxygen and phosphorus.

The molecular motion of a compound is probably the result of the composition of the forces of the molecular movements of its elements, but it is not probable that it is so in the simple mechanical sense in which we represent the composition of two forces as the diagonal of their parallelogram; the elements no doubt retain some of their individuality. Professor Mills, of Glasgow, objects to our saying that water contains H_2O (*Phil. Mag.*, Jan., 1876). He prefers to say that water plus energy equals $H+O$; and that $H+O$ forms water plus energy. He thinks we might with equal exactness say that water is a simple body intermediate between H and O. If matter were only directed motion as he suggests, the compound water might be only compound in the same sense as the diagonal

is a compound in a parallelogram of forces, a simple line intermediate between the two forces H and O, but the conception of motion or force without matter seems to me to require a new definition of matter, or else to require the resolution of both force and matter into motion of luminiferous ether, the existence of which is hypothetical, and the nature of which we assume to be any that suits the requirements of our hypotheses. Had water been a force or motion as simple in its nature as the diagonal in a parallelogram of force, or as any simple force resulting from the combination of two forces acting in different directions, it would not necessarily be resolvable only into the two forces from the union of which it resulted. The fact that no application of force, varying in kind or quantity, has resulted in the production of anything but H and O from water supports the view of the elements of water retaining their individuality, to some extent at any rate, while in combination, and does not encourage us to regard Aq as a simple body or a simple force intermediate between H and O.

In Ag_2O the union is feeble because the normal movements of the elements are not closely harmonious. In H_2O the union is stable because of a closer harmony. In H_2O_2 the second equivalent of O is feebly held, because the normal movement of O is not closely harmonious with that of H_2O . And Ag_2O , we may suppose, decomposes H_2O_2 because of the harmony between the loosely attached oxygen atoms, continuing in their combination, and because the polarities of these atoms are not better satisfied by association with silver or water than they are by the union of two atoms of oxygen into one molecule, which constitutes oxygen in the free state. This partial satisfying of the polarities by the union of two or more polarities into one molecule, constitutes the difference between the chemical activity of free and nascent elements.

Dr. Siemens has recently propounded a theory of the sun's heat, based upon the fact that the radiant heat and light have the power of dissociating the elements of water when they pass through its vapour in a highly rarefied state, and that the dissociated elements, when drawn down to the denser atmosphere of the sun, re-unite, giving out again the heat which had effected their separation. A reasonable objection has been raised to this theory, that is, that the heat which we estimate as the sun's loss is only that which escapes this trap to catch the sunbeams. But, however much heat may escape from the sun into space, it does not seem necessary that we should establish new laws for the conservancy of the solar system. If force radiates from the sun as heat and light against space, diminishing in proportion to the square of the distance from the sun, the same force reflected back from space as from a hollow spherical reflector would come back directly to the sun undiminished. But as space is not a reflector of heat and light, may we not speculate on these overflowing vibrations causing a mechanical reaction, the backward flow of some other force, say gravity? Is it not a more reasonable speculation that gravity should be convertible with the other forces and keep up the cycle of natural change, than that all the stars are pouring forth their heat and light into infinite space, receiving nothing in return, and so to go on till, in the lapse of countless ages, all comes to utter darkness and inconceivable cold? Our common experience is that a hot body tends to become cold, but he would be a bold physicist who would assert that the universe as a whole had the same tendency. On the one hand we have no experience of the universe as a whole, and on the other we have experience of numberless cases where, in ignorance, it was supposed that force was lost, but in which further knowledge showed that it was not lost but converted into another form. We are as yet unacquainted with any means by which gravity may be converted directly into any force except mechanical motion, but the conversion of the forces is a subject so new, in comparison with the length of time during which the forces have been studied as separate and unconvertible

agents, that it would be unreasonable to assume that because we have not yet seen the means of converting the force of gravity into heat or light except through the intervention of mechanical motion, we are not likely to do so. We have converted heat into electricity and electricity into heat—magnetism into electricity and electricity into magnetism, and so on in many other cases, which have been among the most interesting achievements of science during the last half century.

If the action of gravity be reduced to that of radiant force acting in all directions, the apparent attraction being the subtraction of impacts on that side of a body to which the action of gravity tends to move it, then all bodies must have a diadynamous property at least as perfect as the diaphanous and diathermanous property of air. The proportion of impact force a body transmits compared to that which it intercepts, gives the difference in weight of a second body weighed above and below the first. The proportion of impact force which a body intercepts, compared to that which it transmits, gives its mass, and the excess of impacts it receives in one direction over the other multiplied into its mass gives its weight. One very marked difference between gravity and other forces is that the relationships which an element bears to all the other forms of force are changed by chemical combination, while its relation to gravity remains constant. When iron combines with chlorine, its relations to heat, light, electricity, and magnetism are essentially changed, but its weight remains the same. On this exceptional constancy in the relationship between gravity and matter in its different states of combination depends the possibility of exactness in chemical science.

It is with pleasure, not unmingled with reverence, that we feel our views of force and matter extending and promising that we shall see the unity and harmony of all nature. It must be regarded as a narrow view, a small-world prejudice, to look upon our solar system as a centre, radiating force upon all creation, giving out force, in the form of heat and light, in quantity inconceivably greater than it receives. Our common experience is that there is a general tendency in all nature to the restoration of physical equilibrium, the bent spring tends to relax, the suspended weight to come to the ground, the hot or cold body to come to the temperature of the bodies surrounding it, and we have naturally assumed, though with too little reason, that a state of rest, of inactivity, of monotony, and of death, is the natural goal to which all things tend.

We do not know that our system is become colder, and the sun less luminous; and if we did, we still do not know that we are not accumulating some other force, at present beyond our discovery.

On the other hand, we are daily becoming more convinced—more certain that force is not destroyed.

We are learning to count the atoms, to weigh the imponderable, and to measure that which has neither size nor shape; and we may with hopeful anticipation look for the laws which govern the chemical action of light and heat, and bring gravity into close relationship with the other forces of nature.

Mr. JOHN PATTINSON—I have much pleasure in moving that our cordial thanks be given to Mr. Proctor for his very interesting and philosophical address. He has dealt with the most mysterious problems of physics, and has given us ample scope for reflection, and our younger members ample material for research.

Mr. N. H. MARTIN—I have much pleasure in seconding the proposal. I have heard the address with great interest, and I look forward with great interest to its perusal. I think that one advantage which will accrue from amalgamation with the Society of Chemical Industry will be that addresses like Mr. Proctor's will be seen by a greatly increased circle of readers.

Mr. PROCTOR then thanked the meeting, and the proceedings closed.

NOTICES OF BOOKS.

Elementary Lessons in Electricity and Magnetism. By SILVANUS P. THOMPSON, D.Sc., F.R.A.S. London: Macmillan and Co.

THIS treatise is avowedly written for beginners, but not with reference to any prospective examination—the exclusive goal which so many of our elementary text-books have in view. A series of exercises and problems is, indeed, appended, not, however, that the student may “get up” the answers, but with the perfectly legitimate object that he may test his own power of understanding what he has read.

Dr. Thompson,—most judiciously in our opinion—does not pre-suppose advanced mathematical attainments on the part of his readers. A knowledge of algebra as far as simple equations and of the first book of Euclid is all that he demands.

The author's method is eminently satisfactory. In the first chapters of his work he sets forth the principal experimental facts of the three great branches of his subject, to-wit, frictional electricity, current electricity, and magnetism. The correlation and explanation of these facts is reserved until afterwards. In so doing he is in harmony with the practice of all truly rational science teachers of the present day who ascend from phenomena to laws, thus making the course of instruction harmonise with that of discovery. This is a capital step in advance as compared with the old method of laying down at the outset certain abstract propositions, and endeavouring afterwards to prove or to illustrate them by observation and experiment. We suspect that no little of the “dry” and repulsive character popularly ascribed to science is due to this old method of teaching.

Prof. Thompson adopts the theory that electricity is unitary and not dualistic in its character, and also that it is neither matter nor energy, though, like both matter and energy, it can neither be created nor destroyed. A doctrine underlying his teachings is that of the conservation of electricity. He shows that “all our electrical machines and batteries are merely instruments for altering the distribution of electricity by moving some of it from one place to another, or for causing electricity when accumulated or heaped together in one place to do work in returning to its former level distribution.”

The author in the body of his work treats in succession of frictional electricity, of magnetism, and of current electricity, proceeding in each case from the elementary phenomena. In the second part of the treatise he enters upon theoretical considerations, discussing electro-statics, electro-magnetism, the measurement of currents, the production of heat, light, and work from electric currents, the relations between light and electricity, induction currents, and electro-chemistry. A final chapter is devoted to an account of electric telegraphs and telephones. In all cases the author's descriptions and explanations are clear, and as full as the moderate compass of the work will permit. We note in one of the earliest paragraphs that whilst some physicists speak of “two electricities,” and of one or of two electric fluids, Dr. Thompson more judiciously speaks of “two kinds of electrification” or of “two electric states.” The notion of an electric fluid he emphatically rejects. The confusions and misconceptions which have sprung from this unhappy term, or rather from the underlying idea, are serious, and it is much to be regretted that it should still figure in popular writings and discourses.

From a paragraph on muscular contraction (p. 185) it appears that the biologist, Swammerdam, anticipated Galvani by a century! “In 1678 he showed to the Grand Duke of Tuscany that when a portion of muscle of a frog's leg hanging by a thread of nerve bound with silver wire was held over a copper support, so that both nerve and wire touched the copper, the muscle immediately con-

tracted.” So that we might, perhaps, speak of “Swammerdamism” in place of “Galvanism.” It is, however, improbable that Galvani was aware of this experiment; nor does Swammerdam seem to have given any further attention to the subject.

Among the chief additions in the present edition of Prof. Thompson's work as compared with the two former, we notice an account of the secondary batteries of Planté and others, of Edison's latest improvements in incandescence lamps, and of Nordenskiöld's observations on the aurora. The question arises, however, whether the causes of this phenomenon are not of cosmic rather than of terrestrial origin. The new units of measurement adopted by the Paris Congress have also been introduced.

Among the works of their class these “Elementary Lessons” must take a very high rank, and may be recommended to all students who wish to acquire a clear knowledge of electricity and magnetism.

CORRESPONDENCE.

ON THE DISCOVERY OF THE PERIODIC LAW.

To the Editor of the Chemical News.

SIR,—It has been lately announced that the Royal Society have awarded “the Davy Medal (in duplicate) to D. Mendelejeff and Lothar Meyer, for their discovery of the periodic relations of the atomic weights.”

Having been the first to publish the existence of the periodic law, in the pages of the *CHEMICAL NEWS*, more than eighteen years ago, I feel, under these circumstances, compelled to assert my priority in this matter.

That both of the above-named eminent chemists have done a good deal to develop the periodic law is admitted, but this admission by no means assumes that either of them was the first discoverer of the law in question. As a matter of simple justice, and in the interest of all true workers in science, both theoretical and practical, it is right that the originator of any proposal or discovery should have the credit of his labour.

I will now give the dates of my several papers on the subject, published by me long before M. Mendelejeff had printed anything upon the question.

In a paper (*CHEMICAL NEWS*, vol. x., p. 59), July 30, 1864, I gave a list of all the then known elements in the order of atomic weight, which was the first ever published. Another table was appended, giving a horizontal arrangement of the more important elements, also in order of atomic weight, with blanks corresponding to some of the missing members of various groups. Thus, in the trivalent group, commencing with boron, there was a blank next below zinc, since filled by gallium, and another blank immediately below cadmium, since filled by indium. It was also pointed out that in the group containing carbon, silicon, titanium, and tin, there was an element wanting having an atomic weight of 73, being, in fact, the same missing element which M. Mendelejeff has recently predicted under the name of eka-silicium.

In an appendix to this paper (*CHEMICAL NEWS*, vol. x., p. 94), August 20, 1864, I announced the existence of a simple relation or law among the elements when arranged in the natural order of their atomic weights, to the effect that the eighth element, starting from a given one, was a sort of repetition of the first, or that elements belonging to the same group stood to each other in a relation similar to that between the extremes of one or more octaves in music. This was accompanied by a horizontal grouping arrangement.

In the *CHEMICAL NEWS*, vol. xii., pp. 83 and 94 (Aug. 18 and 25, 1865), I published a full horizontal arrangement of the elements in order of atomic weight, and proposed to designate the simple relation existing between

them by the provisional term "law of octaves." This law has since been called by M. Mendelejeff the "periodic law."

On March 1, 1866, I read a paper on this periodic law before the Chemical Society, and a notice of this appeared in the *CHEMICAL NEWS*, vol. xiii., p. 113, and also in many other journals. In the *CHEMICAL NEWS*, vol. xiii., p. 130 (March 16, 1866), I wrote as follows:—"I have endeavoured to describe relations actually subsisting among the atomic weights of the elements at present known, but am far from thinking that the discovery of new elements (or the revision of the atomic weights of those already known) will upset for any length of time the existence of a simple relation among the elements when arranged in the order of their atomic weights."

"The fact that such a simple relation exists now affords a strong presumptive proof that it will always continue to exist, even should hundreds of new elements be discovered. For, although the difference in the numbers of analogous elements might, in that case, be altered from 7, or a multiple of 7, to 8, 9, 10, 20, or any conceivable figure, the existence of a simple relation among the numbers of analogous elements would be none the less evident."

Years afterwards the brilliant researches of Roscoe showed that the atomic weight of vanadium was 51.2, instead of 137. This reduction in the atomic weight of vanadium at once placed that metal in the same line as the phosphorus group, thereby confirming the periodic law. It may also be stated that in the *CHEMICAL NEWS*, vol. x., p. 95, I predicted that the atomic weight of indium might "prove to be identical, or nearly so, with those of zinc or cadmium."

To sum up, I claim to have been the first to publish a list of the elements in the order of their atomic weight, and also the first to describe the periodic law, showing the existence of a simple relation between them when so arranged.

I have applied this periodic law to the following among other subjects:—

1. Prediction of the atomic weight of missing elements, such as the missing elements of the carbon group = 73, since termed eka-silicium by M. Mendelejeff.
2. Predicting the atomic weight of an element whose atomic weight was then unknown, viz., that of indium.
3. Selection of Cannizzarro's atomic weights, instead of those of Gerhardt, or the old system, which do not show a periodic law (*CHEMICAL NEWS*, vol. xiii., p. 113).
4. Predicting that the revision of atomic weights, or the discovery of new elements, would not upset the harmony of the law—since illustrated by the case of vanadium.
5. Explaining the existence of numerical relations between the atomic weights (*CHEMICAL NEWS*, vol. xiii., p. 130).
6. Where two atomic weights were assigned to the same element, selecting that most in accordance with the periodic law: for instance, taking the atomic weight of beryllium as 9.4 instead of 14.
7. Grouping certain elements so as to conform to the periodic law instead of adopting the ordinary groups. Thus, mercury was placed with the magnesium group, thallium with the aluminium group, and lead with the carbon group (*CHEMICAL NEWS*, xiii., p. 113). Tellurium, on the other hand, I have always placed above iodine, from a conviction that its atomic weight may ultimately prove to be less than that of iodine.
8. Relation of the periodic law to physical properties—showing that similar terms from different groups, such as oxygen and nitrogen, or sulphur and phosphorus, frequently bear more physical resemblance to each other than they do to the remaining members of the same chemical group (*CHEMICAL NEWS*, vol. x., p. 60).

It is not denied that I was the first to publish a list of elements in the natural order of their atomic weights, and Wurtz has written, in reference to the periodic law, that "it is a circumstance worthy of remark that such varied and unexpected developments arise from the simple idea

of arranging bodies according to the increasing value of their atomic weights. This simple idea was a most important one." ("The Atomic Theory," by A. Wurtz; Translation, p. 170; London, 1880.)

As evidence of the opinion of various writers on the subject the following may be quoted:—

M. Mendelejeff (*CHEMICAL NEWS*, vol. xliii., p. 15):—"It is possible that Newlands has prior to me enunciated something similar to the periodic law, but even this cannot be said of H. L. Meyer."

Dr. Odling, Lecture on Gallium, before the British Association, in 1877:—"Mr. Newlands was the first chemist to arrange the elements in such a seriation that new ones might be predicted to exist where certain gaps are observed in the seriation of atomic weights."—(*Pharmaceutical Journal*, August 25, 1877, p. 144.)

"Fownes's Chemistry," vol. i., 12th ed., 1877, p. 265:—"This relation of the elementary bodies, which is called the 'periodic law,' was first pointed out by Newlands in 1864, and afterwards developed by Odling and Mendelejeff."

Miller's "Elements of Chemistry," Part II., 6th ed., 1878, p. 974:—"Periodic law of Newlands and Mendelejeff." "This periodic law was first pointed out by Newlands in 1864."

"Roscoe and Schorlemmer's "Chemistry," vol. ii., Part II., 1879, p. 506:—"The first attempt to point out that the properties of the elements varied periodically was made by Newlands in 1863." "The law of periodicity was afterwards further developed by Meyer and Mendelejeff."

"Watts's Dictionary," vol. viii., 1879, 3rd Supplement, Part I., p. 729:—"The idea of a periodic relation between the atomic weights of the elementary bodies and their quantivalence and other properties, developed by Mendelejeff in the manner already described (2nd Suppl., 462), was first suggested by J. R. Newlands in 1864."

Dr. Tilden, "Chemical Philosophy," 2nd ed., 1880, p. 246:—"In the year 1866 a very curious observation was made by Mr. Newlands to the effect that when the elements are arranged in a continuous series in the order of their atomic weights, commencing with hydrogen, there is at equal intervals in the series a recurrence of the same or similar general characters, both physical and chemical. This periodic revival of characteristics occurs, with a few exceptions, at about every eighth member of the series, as will presently be shown. This discovery has been elaborately studied by Mendelejeff and Lothar Meyer, and that which has long been vaguely recognised is now fully established, namely, that the properties of the elements stand in a definite relation to their atomic weights."

Sir John Lubbock's Address to the British Association, in 1881 (*CHEMICAL NEWS*, vol. xlv., p. 120):—"A periodicity in the atomic weights of elements belonging to the same class had been pointed out by Newlands about four years before the publication of Mendelejeff's memoir."—I am, &c.,

JOHN A. R. NEWLANDS, F.I.C., F.C.S.

Laboratory, 9, Mincing Lane, London, E.C.
December 11, 1882.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 20, November 13, 1882.

Results of Experiments made on the Electric Candles at the Exhibition of Electricity.—MM. Allard, F. Le Blanc, Joubert, Potier, and H. Tresca.—The results of the observers are given in a tabular form.

Note on the Reproduction of the Iridium Osmides.—H. Debray.—When iridium is heated with iron pyrites we obtain a regulus which on treatment with dilute hydrochloric acid leaves a deposit of crystalline iridium mixed with a black, light, amorphous sulphide, which dissolves very readily in nitric acid. It is therefore easy to separate the iridium from the medium in which it crystallises. It is first converted into a sulphide, which is decomposed at high temperatures, when it takes the crystalline form. This iridium is not absolutely pure; it contains from 1 to 2 per cent of iron, but it crystallises in regular octahedra. It is the same with osmium. This metal, fused with pyrites and a little borax at a high temperature, gives likewise a regulus, from which crystalline osmium can be extracted with its characteristic blue colour, and a black sulphide. The osmium thus obtained does not retain appreciable traces of iron, and has all the characters of the metal, as formerly obtained by the author and H. Sainte-Claire Deville by the action of hydrochloric acid upon the alloy of osmium with tin or zinc. The author has examined the action of pyrites upon mixtures of osmium and iridium in different proportions. He has obtained on treating the regulus successively with hydrochloric and nitric acid a homogeneous crystalline residue composed of regular octahedra with hexagonal plates, which recall certain natural osmides. Osmium and iridium can crystallise together in all proportions without any alteration of form, and are, therefore, isomorphous.

Note on the Telluric Rays, and the Spectrum of Watery Vapour.—J. Janssen.—The author refers to M. Cornu's memoir in the previous number of the *Comptes Rendus*. He criticises the historical part of M. Cornu's paper, and describes his own method for estimating the variations in the hygrometric state of the atmosphere.

Currents produced by Nitrates in Igneous Fusion on Contact with Charcoal heated to Redness.—M. Brard.—The author's chief results are: If into a capsule containing a bath of a nitrate in fusion, there is plunged a piece of carbon heated to redness, we obtain an energetic current, which proceeds from the bath to the carbon in the outer circuit. The nitrates in fusion become very fluid, and acquire the property of moistening heated bodies with which they are in contact to some height above their surface. To obtain a current it is not necessary to plunge the carbon into the bath of nitrate. Nitrates kept in a state of fusion possess great permanence. These salts, which melt at 200°, are not decomposed until about 1000° or 1200°. Up to that point they do not attack the metal crucible, &c., containing them, and even prevent, or at least retard, its oxidation by the fire.

Chemical Studies on the Sugar-Beet.—Hippolyte Leflay.—Continued from the last two numbers.

Exactitude of Determinations made with the Mercurial Thermometer.—J. M. Crafts.—The author advises that thermometers which are destined for laboratory experiments should before graduation be heated for a week or ten days in boiling mercury. This is the only method for obtaining instruments which keep the value of the degree fixed during graduation, and the errors in thermometers which have not undergone this treatment may reach 4° in 300°.

Conclusions from the Hydro-dynamic Experiments in Imitation of the Phenomena of Electricity and Magnetism: Reply to a Memoir by M. Ledieu.—C. Décharme.—The author by his researches has shown the analogy existing between the hydro-dynamic and the electric flux, whence it results that the thermic and the electric flux are assimilable to the liquid flux. The wave-theory, which already explains all the phenomena of light, heat, and of sound, seems to be the secret of Nature.

Electric Deformations of Quartz.—MM. Jacques and Pierre Curie.—See p. 260.

Electrisation of the Air.—M. Mascart.—The author follows up a suggestion of Sir W. Thomson's on con-

tinuous observations of the electrification of the lower strata of the air by determining the potential in a limited volume of gas taken from the ambient air, and withdrawn from the action of foreign electric masses.

Atmospheric Nitrification.—A. Muntz and E. Aubin.—In the Pyrenees the violent electric phenomena which appear as thunderstorms do not exceed the altitude of 3000 metres. Consequently the formation of nitrates under electric influence is below this limit. In rain, snow, and fog on the summit of the Pic du Midi, the authors find that nitrates are substantially absent. Hence the vegetation of high mountains and the soil which it forms must obtain their nitrogenous matters merely from the ammonia of the atmosphere.

Decomposition of Phosphates by Potassium Sulphate at High Temperatures.—H. Grandeau.—Aluminium phosphate heated to a very high temperature with an excess of alkaline sulphate gives an alkaline phosphate and crystalline alumina. This reaction, which is due to M. Debray, has been proposed by M. Derome as a means of determining phosphoric acid. The author examines in what conditions are alumina and phosphoric acid separated from each other in presence of potassium sulphate? For this purpose he heated a mixture of aluminium phosphate and potassium sulphate in a platinum crucible for several hours. He finds that the decomposition of the aluminium phosphate at a very elevated temperature gives rise, not merely to crystalline alumina, but to a double aluminium and potassium phosphate, crystalline and of definite composition. The more the temperature is raised, the more considerable the proportion of alumina becomes. But it is very difficult when operating upon weights at all considerable, to effect, even with the most energetic sources of heat, the complete decomposition of the double phosphate. In most cases we obtain, not the whole of the alumina in the crystalline state, but a mixture of the two products. The experiment has been repeated with intermediate oxides little known, such as those of glucinum, cerium, didymium. The result of the operation has been the same as for alumina. The author has thus obtained a crystalline glucinum and potassium double phosphate. Among the protoxides there are two distinct classes; some, such as lime and magnesia, never yield the oxide if their phosphates are treated with an alkaline sulphate. With others, such as nickel and cobalt, we observe the same phenomena as with aluminium. With other phosphates the case is again different. With chromium and uranium phosphates the final products are potassium chromate and uranate.

Solidification of Various Mixtures of Naphthalene and Stearic Acid.—H. Courtonne.—The author gives his results in a tabular form.

Cæno-cyanine.—E. J. Maumené.—Cæno-cyanine is originally colourless, and obtains its blue-black colour by oxidation and possibly by hydration.

Cause of the Disengagement of Oxygen from Hydrogen Peroxide by means of Fibrine: Influence of Hydrocyanic Acid in Checking the Activity of Fibrine.—A. Béchamp.—The author shows the changes which fibrine undergoes on deoxidising hydrogen peroxide: it loses this reducing power; it no longer liquefies starch paste, and it no longer supports bacteria. It is not in virtue of a physiological process that hydrocyanic acid suppresses the action of fibrine upon oxygenated water.

Justus Liebig's Annalen der Chemie,
Band 215, Heft 2.

Imides of Bibasic Acids.—Dr. Max Landsberg.—The author examines phthalimide and succinimide in order to ascertain whether in these imides an atom of hydrogen can be substituted not merely by mercury and silver, but by metals of the most varied kinds, and if it is possible by starting from these imides to obtain their

ethyl-derivatives, which yield ethyl-amine by taking up water.

Communications from the Chemical Laboratory at Greifswald.—These consist of a memoir by Dr. P. Rodatz on the structure of certain azo-benzol-disulpho-acids; one by the same author on some bromised azo-benzol-disulpho-acids, and a memoir by Dr. H. Wilsing on the sulpho-acids of oxy-azo-benzol.

Mono-brom-pseudo-cumolic Acid and Dibrom-mesitylenic Acid.—H. Süssenguth.—The author describes the preparation of mono-brom-pseudo-cumol and of mono-brom-pseudo-cumolic acid and its salts; the preparation of brom-mesitylenic acid from brom-mesitylene, of dibrom-mesitylene from the oil of coal-tar, and of dibrom-mesitylenic acid.

Cosmos Les Mondes.
No. 9, October 28, 1882.

Detection of Spurious Butter.—M. Dony.—Artificial butter, if heated in a capsule or test-tube to from 150° to 160°, yields little froth, but undergoes a singular kind of ebullition accompanied by violent bumping, which tends to project a part of the sample out of the vessel. The fatty portion of the sample retains its natural colour, and the curdy matter turns brown, and is separated out in the form of clots which adhere to the sides of the vessel. Natural genuine butter, if treated in the same manner, behaves quite differently; it froths abundantly, and the bumping is much less violent. A good part of the brown colouring-matter remains suspended in the butter, so that the total mass preserves a characteristic and uniform brown colour.

Curious Explosions.—M. Pfaundler.—A sealed glass tube containing liquid carbonic acid had been immersed to the depth of some c.c. into a bath of carbonic acid and ether at the temperature of -100° in order to produce the crystallisation of the carbonic acid. Some fine crystals were formed in the submerged part of the tube, whilst a stratum of the liquid acid remained above. The tube was then raised out of the bath by its upper extremity, and in a few minutes there ensued a violent explosion. The second case relates to a large zinc gas-holder, used exclusively for containing oxygen. It had not been in use for six months, but a little gas had been allowed to remain within. When this gas as it issued was tried with a match an explosion took place which ruptured the apparatus. It is probable that the water had gradually absorbed acid vapours from the atmosphere of the laboratory, and had attacked the zinc, disengaging hydrogen.

Detection of Phenol in Urine.—The presence of phenol is commonly shown either by precipitating with bromine water so as to obtain tribromo-phenol, or by producing erythrophenic acid by means of sodium hypochlorite in presence of ammonia or of aniline. MM. T. and D. Tommasi use as acid a mixture of equal parts of distilled water and of pure hydrochloric acid, adding to every 100 c.c. of the mixture 20 centigrms. of potassium chlorate. They stir the urine with a rod of pine wood, which they then plunge for a very short time into the acid liquid. The rod is then exposed to the rays of the sun, and if phenol was present the characteristic blue colour appears in five minutes.

No. 10, November 4, 1882.

A new chemical journal has recently appeared at Leyden entitled "*Recueil des Travaux Chimique des Pays-Bas.*" It will be conducted by MM. Van Dorp, Franchimont, Hooge-Werff, Mulder, and Oudemans.

No. 11, November 11, 1882.

A Substitute for the Sand-bath.—M. Kaistalba.—The author proposes pounded graphite as a substitute for sand.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., October, 1882.
This issue contains no chemical matter.

MEETINGS FOR THE WEEK.

MONDAY, 18th.—Medical, 8.30.
— London Institution, 5.
— Society of Arts, 8. "Dynamo-electric Machinery," by Prof. Silvanus P. Thompson, D.Sc.
TUESDAY, 19th.—Institution of Civil Engineers, 8. (Anniversary.)
— Pathological, 8.30.
WEDNESDAY, 20th.—Society of Arts, 8. "The Utilisation of Waste. A Quarter of a Century's Progress," by Peter Lund Simmonds.
— Meteorological, 7.
— Geological, 8.
THURSDAY, 21st.—Chemical, 8. "On the Condensation-Products of Enanthol," Part II., by W. H. Perkin, Junr., Ph.D. "The Behaviour of the Nitrogen of Coal during Destructive Distillation: with Observations on the Estimation of Nitrogen in Coal," by W. Foster. "On the Absorption of Weak Reagents by Cotton, Silk, and Wool," by E. J. Mills, D.Sc., F.R.S., and Jokichi Takamine. "Note on Nitro-benzyl-cyanide and some Derivatives with Diazo-bodies."
— Royal, 4.30.
— London Institution, 7.
FRIDAY, 22nd.—Quekett Club, 8.

TO CORRESPONDENTS.

L. Rowland Hill.—Many leading physicists adopt this view, but it is by no means universally admitted.

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NOTES ON THE DETECTION OF THE ACIDS (INORGANIC AND ORGANIC) USUALLY MET WITH IN ANALYSIS. For the Use of Laboratory Students. By J. WILLIAM JAMES, Ph.D. (Jena), F.C.S. (Lond. and Ber.), Demonstrator and Lecturer in the Mining School, Bristol.
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JOURNAL OF THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.
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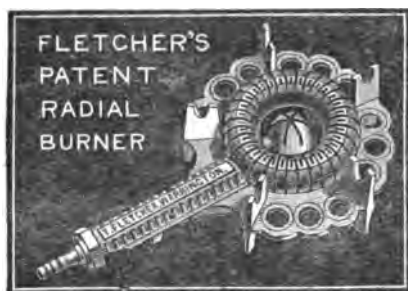
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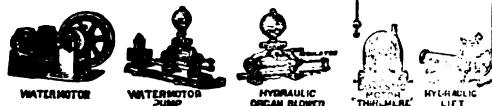
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THE CHEMICAL NEWS.

VOL. XLVI. No. 1204.

RUPERT'S DROPS.

By I. TAYLOR, B.A. (Oxon.)
Science Master at Christ College, Brecon.

It is stated in Chemical Text-books (for example, Roscoe and Schorlemmer's "Chemistry," vol. ii., Part I.; Miller's "Elements of Chemistry," Part II.) that Rupert's drops may be obtained by allowing molten glass to fall into cold water: I find that it is almost impossible to manufacture the drops in such a manner. I have used cylinders of different lengths, with water of various degrees of temperature, with the same result, the glass almost invariably breaking up into a number of small fragments directly it strikes the bottom of the cylinder. The drops may, however, be very easily obtained by using a saturated solution of ammonium chloride—freshly prepared with cold water (6° to 8° C.)—contained in a cylinder about 18 ins. long, the increased specific gravity and cold ensuring the almost complete cooling of the glass before it reaches the bottom of the cylinder.

PYROLOGICAL NOTES.

By Lieut.-Colonel W. A. ROSS, late R.A.

(Continued from p. 273.)

VII. BORIC ACID AND ALUMINIUM PLATE. TWO ANALYSES OF Smaltite.

It is very much to be regretted that Prof. H. B. Cornwall should have allowed himself to make use of the following vaticanic remark in the preface to his "Manual of Blowpipe Analysis," just published at New York:—"No really useful Manual of Blowpipe Analysis can be produced without the aid of Plattner's well known work." As my little "Manual," published in 1880, is the only work to which this observation *ex cathedra* of the "John C. Green School of Science" can possibly refer, I ask your permission to take up the gauntlet thus thrown down, and to attempt to show in your pages, by means of Prof. Cornwall's own book, that it is not only possible to produce something "really useful" to the public in the way of blowpipe analysis, without making it a mere *réchauffé* of Plattner's "Probirkunst" and Von Kobell's "Bestimmung der Mineralien," but that, on the other hand, those modern pyrological works which persistently ignore all advancement or admitted improvement in the mechanical or chemical portions of this science unless they have proceeded from Freiberg, or Munich, or New York, are simply neglecting their own interests not less than those of the public.

Cornwall's qualitative analysis of the mineral Smaltite (Co, Ni, Fe)As₂, page 105:—(1) "To be fused in a shallow cavity on charcoal with a moderate R.F. until the arsenic fumes cease. (2) A small piece of borax glass is added, and the O.F. directed for a short (?) time on the borax. Any iron arsenide present (sometimes about 18 per cent) will be first oxidised, and, if the blast is stopped as soon as the metallic button of arsenides appears bright, while still melted, the iron can be detected in some of the separated glass by oxidising this, with a little more borax if very dark, on platinum wire in O.F. (3) The borax bead will then show the yellow colour indicative of iron, or the green colour due to a mixture of some blue from cobalt with the iron in the borax, if the operation had not been

stopped at the right moment. (4) When the button of arsenides is again oxidised with fresh borax the glass will be coloured blue, since the cobalt arsenide will next be oxidised and dissolved. (5) After the cobalt (sometimes about 20 per cent, 0.05 per cent giving a strong blue colour to a borax bead) is removed, there will remain, if nickel and copper are present, a button of the arsenides, which will no longer remain bright while melted, as it did in the presence of the cobalt arsenide, but will begin to show a film of nickel arsenate. (6) The blast should be stopped now, and the button again oxidised beside fresh borax, to which it will at first impart the reddish brown nickel colour. (7) Any copper present (about 0.20) can be found in the remaining button by means of S.Ph. (microscopic salt) on wire in O.F., shaking off the bead into a porcelain dish, and treating it in a moderately deep cavity on charcoal beside a bit of tin, half as large, with R.F., just long enough to fuse the two together. (8) The tin will, of course, not dissolve in the S.Ph., but only adhere to it. The bead *when cold*, will be distinctly red and opaque, or only slightly reddish, according to the amount of copper present. The red colour is due to the formation of cuprous oxide (suboxide, Cu₂O). (9) The R.F. must not deposit soot on the bead."

The student must remember that the whole of this long and complicated series of processes, which if there be much cobalt, iron, and nickel, and, as is always the case, a mere trace of copper present, will occupy some hours, is simply qualitative, and that he is expected to go through these prolonged and fatiguing operations with a mouth blowpipe, for the mere purpose of detecting the above-mentioned three metals and trace of copper in this ore; and (by way of encouragement) Prof. Cornwall adds, he "will not find it easy to follow accurately the above changes in the appearance of the melted button of arsenides, especially if it is small."

Qualitative Analysis of Smaltite by means of Al. Plate and Boric Acid.

(1) Paste on Al. plate O.P., a copious white sublimate, volatilising in H.P. with garlic smell (large proportion of arsenic): with charcoal slip, O.P. no further sublimate (no other volatile metal).

(2) The cake which forms, turned over occasionally, is roasted by P.P. on the bare plate until all the arsenic is sublimed,* and the powder applied to a boric acid bead O.P.; instantaneous, blue-green pyrochrome, with one or two blue-black opaque balls, showing a coppery suffusion after H.P. (trace of copper); black opaque balls, numerous in proportion to the quantity present—violet after H.P., which, on addition of soda O.P., afford a pink bead; blue hot (cobalt); brown-black opaque balls, with rust-like matter round them—numerous in proportion to the quantity present—(iron); green fragments, showing a white metallic lustre after H.P.—numerous in proportion to the quantity present—(nickel).

If Prof. Cornwall doubts the fact of these reactions, not having tried them (which is the easiest and most usual form of objection to my processes), I can refer him to Herr Pufahl, the Chemical Assistant of Herr Professor Bruno Kerl, of the Imperial Mining Academy, Berlin, who has (very kindly) tried them, and published his experience in the "Berg und Hüttenmännische Zeitung," vol. xli., p. 101, No. 11, March 17, 1882.

The Antiseptic Properties of Carbonic Acid.—H. Kolbe.—The author concludes from his many and extensive experiments that carbonic acid is an excellent agent for preventing beef from putrefying and preserving its flavour for some weeks. Mutton behaves differently, and after remaining for eight days only in carbonic acid it gives off a putrid odour. Veal is not protected nearly so well as beef.—*Journ. für Praktische Chemie.*

* There is no other known method of roasting by which the arsenic can be so separated.

ON THE
PREPARATION OF THE ALKALINE
POTASSIUM PERMANGANATE SOLUTION
USED FOR WATER ANALYSIS.

By JOSEPH STAPLETON.

DR. TIDY appears to have been the first chemist to draw attention to the difficulty of preparing this well-known reagent free from ammonia.* The subject has recently been revived in the *CHEMICAL NEWS* by Mr. Reuben Haines (*CHEMICAL NEWS*, vol. xlv., p. 229). The difficulty is undoubtedly real, and any attempts at its reduction will probably be of interest to chemists using the "ammonia process" of water analysis.

Mr. Haines describes briefly but sufficiently the devices tried by Dr. Tidy for preparing the solution, and he gives his own method of operating. As regards Mr. Haines's method, I am inclined to think from my experience that with some samples of caustic potash he would have great difficulty in obtaining the solution anything like free from ammonia in a reasonable time. I am decidedly of opinion, from a lengthy course of experimenting, that the potash is the chief source of the ammonia evolved during the preparation of the solution. Nitrogenous matter in some form or other appears to be present in most commercial samples of potash, and seemingly this nitrogenous matter is not entirely removed by fusing the potash at a dull red heat. This fact was known to myself and others previous to Dr. Tidy placing it on record in his valuable paper (*loc. cit.*) before the Chemical Society.

A device which has proved very serviceable in my hands for getting rid of a great part of this nitrogenous matter is to make the potash solution with rather hard water, containing dissolved calcium carbonate (New River Company's water for example). The precipitate of calcium carbonate thus formed by neutralisation of the carbon dioxide in the water apparently carries down with it a large portion of the nitrogenous matter. The precipitate is allowed to subside as completely as possible, the subsidence being generally completed in twenty-four hours, though more time may be allowed with advantage. If, after standing for twenty-four hours small flakes of suspended matter are noticeable in the solution, filtration through asbestos may be employed, but this is rarely necessary, the solution being generally bright and clear after standing for the length of time stated. The potassium permanganate is dissolved in a separate portion of hot distilled water, and mixed when cold with the potash solution; the mixed solutions are then made up to about half the proper bulk with distilled water.

The alkaline permanganate solution thus prepared will yield a comparatively large quantity of ammonia by further purification. The best method of effecting this appears to be by distillation, but the usual method of distillation is attended with serious inconveniences in the fracture of the retort and frequent loss of the entire contents. I have known three or four retorts to be broken in succession just as distillation commenced. This troublesome feature may be very satisfactorily overcome by passing steam at atmospheric pressure through the liquid, the steam being led very nearly to the bottom of the retort. When the steam is passing through the solution tumultuously, heat may be applied to the retort by a rose Bunsen, otherwise the distillate comes over very slowly. It is even advisable to heat the solution on a water-bath before placing it in the retort; for subsequent augmentation of the volume of the solution from condensation of the steam is thereby greatly lessened. The "rousing" action of the steam is much assisted by having pieces of ignited pumice stone in the retort.

The distillate is nesslerised after a few c.c. have collected, and this is repeated until only 0.005 m.grm. of

ammonia is obtained from 1 litre of the alkaline permanganate under operation. When this point is reached the solution may be considered practically free from ammonia. The distillation rarely takes longer than one hour.

It is of importance to use for generating the steam, water that does not give off ammonia continuously whilst boiling, otherwise of course the results of the process are misleading.

The retort ought not to be more than one-third full of the solution, as the tumultuous boiling is otherwise liable to jerk portions of the liquid into the neck of the retort, and from thence it gets into the distillate, and thus nesslerising is rendered impossible. If possible it is advisable to slant the neck of the retort upwards with a view to preventing this.

Another precaution I have found from experience to be desirable is to support the retort upon a tripod stand covered with wire gauze, from which it should not be removed at the conclusion of the operation, but the contents emptied by a syphon. By this means should a fracture of the retort have taken place while working, the loss of the contents is avoided.

Summarising briefly, the process consists in (1) the purification of the potash solution by a kind of "Clark's process," and (2) distillation of the mixed solutions of alkali and permanganate, aided by "direct steam."

The process has been in constant use for some two years, both in my own hands and by several other chemists to whom it has been communicated, and invariably with satisfactory results.

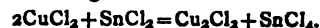
Laboratories of the Pharmaceutical Society,
17, Bloomsbury Square, W.C.

VOLUMETRIC DETERMINATION OF
COPPER, IRON, AND ANTIMONY BY THE
PROCESSES OF M. F. WEIL.

§ 1. Determination of Copper.

Theory of the Process.—The process depends on the following principles:—Hydrochloric acid in great excess is the most sensitive reagent for detecting the presence of copper. In presence of such an excess and at the boiling heat, the least trace of copper chloride communicates a very decided greenish yellow tint to the solution. The more free hydrochloric acid is present the more intense is the colouration.

Stannous chloride instantly converts cupric salts dissolved in an excess of hydrochloric acid into cuprous salts, which are soluble and absolutely colourless. The reaction takes place according to the formula—



At the moment when by the addition of the stannous chloride, the greenish yellow of the hydrochloric solution has entirely disappeared, and the liquid becomes colourless, like distilled water, the reaction is complete.

The volume of solution of stannous chloride, titrated by means of a known quantity of pure copper, which has to be employed for the complete decolouration of the substance under analysis, indicates with the utmost exactness the quantity of copper contained in the sample.

When titrating at a boil the flask is filled constantly with hydrochloric vapours, which prevents the least re-oxidation, during the process, of the cuprous chloride formed.

Dissolve 5 grms. of the ore or cupriferous matter in question in hydrochloric or sulphuric acid, or in water. Introduce the solution into a graduated glass cylinder, and make up to 250 c.c.

For preparing the standard tin solution, dissolve 4.5 to 5 grms. tin crystals in about 100 grs. water and 30 grms. hydrochloric acid, and filter into a half-litre flask. Fill

* *Journ. Chem. Soc.*, 35, p. 62.

up the half-litre with water acidified with about 40 per cent by volume of hydrochloric acid.

For standardising the tin solution introduce by means of a pipette 10 c.c. of the normal copper solution No. 1 (see below) into a small flat-bottomed flask of white glass, add 25 c.c. of hydrochloric acid, and heat to a boil by placing the flask upon a hot plate. The boiling solution is of an intense greenish yellow; the solution of tin to be standardised is run in with a burette graduated in tenths of a c.c. As soon as the liquid on stirring shows merely a feeble colouration, the tin chloride is added drop by drop, still stirring. When the addition of a drop completely decolourises the liquid (a similar flask of distilled water may be used for comparison), the quantity of tin solution required to decolourise 0.1 grm. of pure copper in hydrochloric solution is known.

The actual analysis is executed in the same manner, introducing 10 c.c. of the solution of the sample into the white glass flask, adding 25 c.c. of hydrochloric acid, and running in the standard tin solution drop by drop to the boiling solution till it is completely decolourised. After each series of determinations the tin solution must be re-standardised.

For ores or alloys which have to be dissolved in nitric acid or *aqua regia*, we dissolve 5 or 2 grms. in nitric acid or *aqua regia*, and evaporate to dryness or nearly so in a porcelain capsule. The residue is re-dissolved in hydrochloric acid, and the solution made up to 250 c.c. with water. The whole is well stirred. 10 c.c. of this solution are then mixed with 5 to 10 c.c. of hydrochloric acid, and evaporated to dryness in the porcelain capsule.

The absence of nitric acid may be ascertained by means of a slip of iodised starch paper. The hydrochloric vapours do not turn the paper blue except nitric acid or free chlorine is present. In that case the liquid is evaporated to dryness for a third time along with hydrochloric acid. The residue is dissolved in 25 c.c. of hydrochloric acid and titrated as above.

§ 2. Determination of Iron.

Hydrochloric acid gives solutions of ferric chloride a yellow colour, which stannous chloride decolourises, reducing the iron to the ferrous state. When there are 2½ volumes of free hydrochloric acid to 1 vol. of the ferric solution, the yellow colour is so well marked, and the decolouration by stannous chloride so definite, that no indicator is needed. The iron is titrated with the tin solution standardised with pure copper. The volume of tin chloride used indicates the quantity of iron in the sample but expressed by its equivalent in copper. We require merely to multiply the result by the coefficient 0.88328 to find the percentage of metallic iron. For executing the process weigh and dissolve 5 or 2 grms. of the sample. Introduce 10 c.c. of the solution (containing the iron in the state of ferric chloride, 250 c.c. of the solution containing 2 grms. of the sample) into a small porcelain capsule, and add 10 c.c. of the normal solution of copper = 0.04 grm. of pure copper of bottle No. 2. Evaporate the whole to the third or fourth of its bulk. Pour this concentrated solution into a white glass flask, and add 25 c.c. of hydrochloric acid which have served to rinse completely the porcelain capsule, and titrate with the tin solution to decolouration. Add further from 50 to 40 c.c. of hydrochloric acid, and if this addition produces a slight colouration add tin solution drop by drop till it entirely disappears. In calculating the result the number of c.c. of the tin solution answering to the 10 c.c. of copper added must be deducted.

For ores and substances containing more than 2 per cent of iron the addition of copper is needless. If the solution under analysis contains the iron wholly or partly in the ferrous state, we add to the 10 c.c. taken for the assay a little of an aqueous solution of potassium permanganate until a slight permanent red colour remains, and then with hydrochloric acid until the vapours given off no longer give a blue colour to iodised starch paper.

§ 3. Simultaneous Determination of Iron and Copper.

Take 5 grms. of ore = 250 c.c. of solution. Suppose 10 c.c. of this solution have required 25 c.c. of standard tin. But 10 c.c. of normal copper solution = 15.8 c.c. tin solution, and 25 c.c. of tin solution at this strength represent 79.10 per cent of copper and of iron represented by its equivalent in copper.

For the titration of the iron alone introduce 10 c.c. of the solution to be analysed into a flask. Add 30 c.c. of water, 5 to 10 c.c. of hydrochloric acid, and 3 to 5 grms. of pure granulated zinc. Boil for about twenty minutes, and filter the solution. The filtrate contains all the iron in the ferrous state, whilst all the copper remains with the excess of zinc upon the filter. Add to the filtrate, mixed with the washing-water, solution of permanganate until a permanent rose colour appears. Concentrate to about 5 c.c., heating till the vapours no longer turn iodised starch paper blue, and titrate as already explained.

§ 4. Determination of Antimony.

First Process.—Stannous chloride instantly converts antimonious chloride into antimonious chloride. The solutions of both these chlorides are colourless. On adding to the solution of antimonious chloride a given volume of a solution of copper of known strength, and a large excess of free hydrochloric acid, the mixture takes a greenish yellow colour. The volume of tin solution (standardised with copper) which has to be used to decolourise the mixture, indicates the sum of copper and antimony. On deducting from this sum the quantity corresponding to the known quantity of copper added, the remainder is the volume of tin solution which has served for the reduction of the antimonious chloride. The quantity of copper corresponding to this volume, multiplied by 0.06214, gives the weight of metallic antimony in the sample.

Second Process.—This process is based upon the fact that antimonious chloride is not re-oxidised upon prolonged contact with the air, whilst the solutions of cuprous chloride are completely re-oxidised on exposure, and in some hours resume their original greenish yellow colour. A first titration with the tin solution indicates, consequently, the volume of tin chloride corresponding to the sum of copper and antimony. On letting the solution remain exposed to the air for nine hours it resumes its primitive colour, and on re-titrating the volume of tin solution employed indicates merely copper.

When making up the solutions of antimonious samples to 250 c.c. it is necessary to employ an aqueous solution of tartaric acid to prevent precipitation.

§ 5. Simultaneous Determination of Antimony and Copper in the same Substance.

The mode of operation may be inferred from the second method given for the determination of antimony.

Substances containing Antimony, Copper, and Iron.—Dissolve 2 or 5 grms. of the sample in concentrated nitric acid; evaporate to a small volume and filter. The filtrate made up with water to 250 c.c. now contains merely the iron and copper, and is treated as above directed. The residue on the filter contains all the antimony, and is dissolved in hydrochloric acid, and treated with permanganate. The concentrated solution containing all the antimony as antimonious chloride is titrated as above.

Preparation of the Normal Copper Liquids.—No. 1 and No. 2.—No. 1. Powder pure crystalline copper sulphate, dry it between white blotting papers; dissolve 19.6675 grms. in about 200 grms. water, and make up to half a litre.

No. 2. Operate in the same manner, but use only 7.867 copper sulphate.—*Revue des Mines.*

Second Anhydride of Mannite.—A. Fauconnier.—The author submits mannite to dry distillation in a vacuum. The portions collected at 160° to 190° under a pressure of 0.03 m. consist in part of the second mannitic anhydride, C₆H₁₀O₄.—*Comptes Rendus.*

THE REMOVAL OF FIXED GLASS STOPPERS.*

WHEN the glass stopper of a bottle is ground fine enough to prevent leakage and is well put into its seat, it is generally somewhat difficult to get out. Often it is impossible to remove it by the ordinary means of tapping it and unscrewing with the fingers, and then most persons sacrifice the bottle by breaking off the neck. A glass-stoppered bottle that is so well ground as not to require the slovenly use of grease, or other aids to bad work, involves a good deal of skilled labour, and it is a real waste to destroy it, even if this can be done without any loss of the contents in breaking it. It is a fact not generally known that the very finest and most skilful stoppering that is practicable on a large scale and at moderate cost is not entirely effective against loss of many volatile liquids. A tray of fifty one-pound bottles of ether, kept in a cool cellar, and carefully weighed from time to time, lost at the rate of more than an ounce a month throughout the whole experiment, although stoppered as well as practicable, and never agitated. When agitated, as by transportation, and especially when transported in warm weather, the loss must be many times greater, and accidental imperfection in stoppering, or in the exposure of a box of bottles to a summer sun in long transportations, will occasionally cause the loss of a considerable part, or even the entire contents of some bottles, so that they reach their destination partly or entirely empty, but with little or no sign of leakage perceptible, so that the bottles look as though they had been put up partly full or empty. And leaks so small as not to be discoverable when put up are quite sufficient to empty a bottle during transportation. These difficulties are greatest with such liquids as chloroform, ether, and nitrite of amyl, and the latter is the most difficult of all. All these stoppers require to be put in as tightly as it is possible to put them in, and all stoppers are screwed in with what is called a stopper wrench, and such a wrench is needed to take them out. This is a piece of hard wood about $3\frac{1}{2}$ inches long by about 1 or $1\frac{1}{2}$ inches in breadth and depth. In the middle of one side a mortise is cut nearly through just long enough and wide enough to admit the flat part of the largest size stopper. This applied to the stopper gives a very considerable leverage, and with it stoppers are screwed in by turning them in the direction of the movement of the hands of a watch, as all right-hand screws are put in. To take the stopper out it must, of course, be unscrewed or turned in the opposite direction. In this way almost all stoppers may be taken out safely if the neck of the stopper be strong enough to bear the strain, especially if the stopper be smartly tapped, first on one side and then on the other, by the wooden wrench before it is applied to unscrew it. But some liquids have a tendency to cement the stoppers into their seats either by drying in the joint or by a slight action upon the glass surfaces. Such liquids as solutions of soda and potassa, and especially the disinfectant solution of chlorinated soda, almost always render the stoppers immovable by any ordinary means, and even the stopper wrench will often fail to start them. It is highly probable that half the bottles used with such liquids are sacrificed before the contents can be got at, and in breaking off the necks the break often extends so that a part of the contents is liable to be lost.

When a stopper resists all management—by warming the neck with a cloth wet with hot water, by tapping, and by the wrench, or by all these in combination—there is another means which will almost always succeed. Let the bottle be inverted so as to stand on the stopper in a vessel of water, so filled that the water reaches up to the shoulder of the bottle, but not up to the label. The vessel

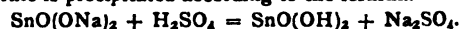
should be so large that the bottle stands in an inclined position, or otherwise a portion of air may be trapped in the gutter between the mouth of the bottle and the stopper, and thus prevent the access of the water to the joint which is to be soaked out. The bottle should stand in this position over night, and if still refractory, for another day and night, and if still tight, three or more days, and in such cases the water should be warm at first and again quite hot for the last five minutes before the wrench is applied. There are many bottles which are very valuable, and the better the stoppering the more valuable they are. Almost all such may be saved by the means indicated, if the necessary time and patience be given.

Many bottles which are hardest to unstopper by reason of the action of the liquids on the glass are unfit for any after use, and might about as well be sacrificed as not, were it not for the liability of losing the contents in breaking them.

NOTE ON THE PRECIPITATION OF STANNIC OXIDE FROM SODIUM STANNATE.

By PETER T. AUSTEN.

WHEN a solution of sodium stannate is acidified, stannic hydrate is precipitated according to the formula—

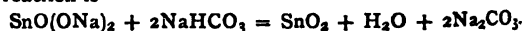


The precipitate dissolves on addition of an excess of the precipitant. The precipitated stannic hydrate is voluminous, flocculent and gelatinous, resembling aluminic hydrate. So far as I have been able to ascertain, no other decomposition of the stannate, than in the manner indicated, has been effected.

I was surprised to find that, on passing a stream of carbonic acid through a strong solution of sodium stannate containing an excess of sodium hydroxide, a dense, heavy, and rapidly subsiding precipitate of stannic oxide was formed, the reaction being—



The same precipitation occurs when, instead of carbonic acid, the solution of sodium stannate is boiled with pulverised sodium hydrogen carbonate. In this case the reaction is—



When dry, the precipitated SnO_2 forms a heavy white extremely fine powder. The reaction affords an excellent method of producing stannic oxide in quantity.—*American Chemical Journal*.

New Brunswick, N.J.

DETERMINATION OF BORACIC ACID.

By EDGAR F. SMITH.

WHEN a solution of manganese sulphate is added to one of borax, and to this mixture an equal volume of alcohol, there separates rapidly a white flocculent precipitate of manganese borate, MnB_4O_7 , insoluble in the alcoholic liquid. The excess of manganese sulphate remains in solution, and can readily be determined in the filtrate from the borate after the expulsion of the alcohol. To ascertain whether the above might be available quantitatively, the following solutions of definite strength were prepared, and the experiments recorded.

1. A solution of manganese sulphate, made by dissolving 3 grms. of anhydrous MnSO_4 in 250 c.c. H_2O . 10 c.c. of this solution would then correspond to 0.0600 gm. MnSO_4 .

2. Potassium permanganate solution of such strength

* From an "Ephemeris of Materia Medica, Pharmacy, Therapeutics, and Collateral Information," by Edward R. Squibb, M.D., Edward H. Squibb, S.B., M.D., and Charles F. Squibb, A.B. Brooklyn, N.Y., November, 1882.

that 18.5 c.c. were equivalent to 10 c.c. of I or 1 c.c. $\text{KMnO}_4 = 0.00324$ grm. MnSO_4 .

3. Borax solution: 10 grms. well crystallised borax dissolved in 1 litre of H_2O .

The manner of conducting each experiment was as follows:—To 10 c.c. of the borax solution were added 10 c.c. MnSO_4 solution and an equal volume of strong alcohol. The whole was well mixed, allowed to stand, carefully covered, for one half-hour, when the manganese borate was filtered rapidly (best with a suction pump), and washed well with alcohol. The filtrate and washings were placed in a platinum or porcelain dish and evaporated to dryness on a water-bath. The residual manganese was then determined according to Volhard's method* by dissolving it in water, adding zinc-sulphate, then heating to almost boiling, and carefully running in potassium permanganate until the liquid assumed a pink colour. The quantity of manganese sulphate thus found and deducted from the whole amount of the salt added, gave a difference representing the manganese sulphate which had combined with the borax. After calculating the amount of manganese oxide to which the sulphate, found by difference, is equivalent, the following equations were employed:—

$\text{MnO} : 2\text{B}_2\text{O}_3 :: \text{amt MnO} : \text{corresponding amt B}_2\text{O}_3 (x);$
and

Orig. sub. 10 c.c. borax solution : $x :: 100 : y$ (per cent B_2O_3 in 10 c.c. of the borax solution).

Experiments.

Number	Borax of solution Anal. used.	MnSO_4 solution added.	No. c.c. KMnO_4 requ'd for excess of MnSO_4 .	MnSO_4 in combination with B_2O_3 Grm.	MnSO_4 in combination found with B_2O_3 Grm.	Per ct. of B_2O_3 .
1.	10 c.c.	10 c.c.	6.4 c.c.	0.0207	0.0393	36.44
2.	"	"	6.1 "	0.0198	0.0402	37.27
3.	"	"	6.3 "	0.0204	0.0396	36.71
4.	"	"	6.3 "	0.0204	0.0396	36.71
5.	"	"	6.5 "	0.0210	0.0390	36.16
6.	"	"	6.4 "	0.0207	0.0393	36.44
7.	"	"	6.5 "	0.0210	0.0390	36.16
8.	"	"	6.4 "	0.0207	0.0393	36.44
9.	"	"	6.2 "	0.0201	0.0399	36.99
10.	"	"	6.3 "	0.0204	0.0396	36.71
11.	"	"	6.3 "	0.0204	0.0396	36.71
12.	"	"	6.4 "	0.0207	0.0393	36.44
13.	"	"	6.5 "	0.0210	0.0390	36.16
14.	"	"	6.3 "	0.0204	0.0396	36.71
15.	"	"	6.4 "	0.0207	0.0393	36.44
16.	"	"	6.3 "	0.0204	0.0396	36.71
17.	"	"	6.5 "	0.0210	0.0390	36.16
18.	"	"	6.4 "	0.0207	0.0393	36.44

The calculated percentage of B_2O_3 in borax is 36.60, and from the experimental results it will be observed that the method can be successfully applied in the analysis of soluble borates.

In estimating the boracic acid in insoluble borates, as tourmaline, the following course was pursued:—The finely pulverised substance was fused with a weighed quantity of pure sodium carbonate, the fused mass exhausted with water, and to the filtrate containing all the sodium borate, together with some sodium silicate and aluminate, was added an amount of pure ammonium sulphate molecularly equivalent to the sodium carbonate. The solution was then digested until all the ammonia was expelled and the volume of the liquid largely reduced. Any silicic acid or aluminum hydrate which had separated was now filtered off, and the precipitate thoroughly washed with hot water. The solution, again reduced in volume and containing only the borate and sulphate of sodium and excess of ammonium sulphate, was mixed with a definite amount of a manganese sulphate solution (strength previously determined), alcohol added, and after standing one half-hour the borate was removed by filtration, the filtrate

evaporated to dryness, and the residue carefully ignited to expel the ammonium salt. The manganese sulphate left was dissolved in water, and the same procedure as indicated in the preceding experiments was carried out.

In a specimen of tourmaline from New York the boracic acid found by this method was 9.70 per cent. Another portion of the same material with Marignac's method* yielded 10 per cent B_2O_3 . In another tourmaline (locality unknown) two determinations by this method gave 6.55 per cent B_2O_3 and 6.32 per cent B_2O_3 , while with Marignac's method the amount obtained was 6.80 per cent B_2O_3 .

In some instances upon evaporating the alcoholic solution preparatory to determining the excess of manganese sulphate, brownish flocks separated. These were always dissolved in a little sulphuric acid and then evaporated to dryness.

The writer is under many obligations to Messrs. N. Wiley Thomas, S.B., and W. H. Jarden, S.B., for their assistance in the execution of the details of the above method.—*American Chemical Journal*.

Muhlenberg College, Allentown, Pa., June 26, 1882.

ON THE REDUCTION OF FERRIC SOLUTIONS.

By PETER T. AUSTEN and GEO. B. HURFF.

ALTHOUGH numerous volumetric methods have been proposed and used for determining iron, there seems to be none that possesses the simplicity, accuracy, and elegance of the titration with potassium permanganate. In the analysis of iron ores by the use of this method, however, there are a few steps which are still open to improvement.

The remarkable discovery of Zimmermann,† that the addition of manganese sulphate to solutions of ferrous chloride entirely prevents the liberation of chlorine on the addition of potassium permanganate, thus making it possible to titrate directly in a chlorhydric acid solution, has relieved the analysis of iron ores of one of its most irksome steps, the conversion of the chlorhydric acid solution into the sulphuric acid solution preparatory to reduction and titration with potassium permanganate.

The only remaining objection has been that the reduction of the ferrous solutions is liable to be unsatisfactory, either from incompleteness, danger of loss, or the length of time demanded. The reduction by zinc is objectionable because the zinc is liable to be impure, containing carbon or iron. A control determination of the iron can of course be made, and the amount introduced into the analysis deducted, but this is a method never advisable in analysis if it can be avoided, and in this case also increases the amount of work. If the solution is heated, oxidation easily takes place at the end of the reduction when all the zinc has been dissolved, while if an excess of zinc is used it takes time to dissolve the excess. If the excess is not dissolved, metallic iron may be precipitated.‡ Rose-Finkener§ suggests having the solution dilute and hanging a little stick of zinc in it by means of platinum wire, but it is doubtful if this method is very practical. The use of zinc dust as recommended by R. Drown|| appears to us to be open to the objection just stated in regard to ordinary zinc, viz., that it often contains iron, thus rendering control determinations, deductions, and extra labour necessary. It is claimed for amalgamated zinc and platinum as an advantage that only pure zinc is dissolved, the impurities not passing into solution. A weighty objection to this method is, however, that so much time is lost by it. The reduction in this way always takes several hours; in fact one recent text-book¶ directs twenty-four hours. Mag-

* *Zeitschrift für analyt. Chemie*, 1, 405.

† *Ber. d. d. chem. Ges.*, 14, 779.

‡ Mitscherlich, *Zeit. anal. Chem.*, 2, 72.

§ Rose, "Quant. Anal.," 1871, 100.

|| *Zeit. anal. Chem.*, 18, 98.

¶ Cairns, "Manual of Quant. Anal.," p. 45.

nesium reduces well, but has the disagreeable property of floating on the surface. The reduction with hydrogen sulphide* requires a tedious evaporation.

It was our endeavour, therefore, to find some method by which ferric solutions could be quickly reduced and which would require no corrections. The following procedure was found to answer admirably.

The ferric chloride solution, which should contain about 5-10 c.c. of free chlorhydric acid and about 0.1 gm. of metallic iron in 100 c.c., is placed in a 300 c.c. flask with a long neck, diluted to 200 c.c., and heated nearly to boiling. The heat is then removed, and a saturated solution of sodium sulphite is added in small amounts (about 1 c.c. at a time) till 15-20 c.c. in all have been used. While adding the sulphite, it is well to give the ferric solution a revolving motion by gently twirling the flask. The solution becomes colourless, showing that all the ferric chloride is reduced to ferrous chloride. The sodium sulphite which we use is obtained by re-crystallising the pharmaceutical article, and forms beautiful crystals which are perfectly free from iron. As soon as the solution of the sulphite has all been added, a rubber stopper and tube† are inserted, the pinch-cock *b* opened, and the liquid heated to boiling and kept at a brisk boil.

It is of course necessary that the last traces of sulphurous acid should be entirely expelled before titration, since any of it remaining would be oxidised by the permanganate and counted as iron. To ascertain if the steam is entirely free from sulphurous acid it is allowed to pass into a test-tube containing about 50 c.c. of water to which a little sulphuric acid and a drop of potassium permanganate solution has been added. If there is the slightest trace of sulphurous acid in the steam the liquid will at once be decolourised. If the steam is allowed to pass for some time through this solution of permanganate, it will decompose it, but this does not interfere in any way with the sharpness of the test. As soon as the test shows that the sulphurous acid has all been driven off, the end of the tube is washed off with a little hot water, the heat removed, and the pinch-cock *b* closed. The end of the tube is allowed to dip into a beaker of cold distilled water. As soon as the flask has cooled enough to have a vacuum within it, which generally occurs in a few minutes, the clip is opened and the cold water allowed to run in in portions so as to thoroughly wash out the tube. The flask is allowed to fill till the liquid stands at about the beginning of the neck. The clip is then closed, the right-hand tube removed and the contents of the flask cooled‡ under the tap. The manganese sulphate is next added and the titration proceeded with.

The above method of procedure works as well with sulphuric acid solutions as with chlorhydric acid solutions. The reduction and titration together take from fifteen to twenty minutes. A number can of course be run at the same time. The following experiments show the accuracy of the method:—

Subs. taken.	Weight taken.	Per ct. of Fe found.	Per ct. of Fe calc.	Difference Per cent.
Ammonium-Iron Alum	1	11.529	11.618	-0.089
" "	1	11.649	"	+0.031
Ammonium - Ferrous Sulphate	1	14.291	14.285	+0.006
" "	1	14.291	"	+0.006

In another series of experiments 0.2 gm. of pianoforte wire was dissolved in dilute chlorhydric acid, diluted to about 150 c.c., oxidised with permanganate, the chlorine boiled off and then reduced in the manner described above. The titrations required the same number of c.c. of permanganate as the same amount of the same iron used in setting the standard of the permanganate, viz., 16.5-16.6.

* Fresenius, "Quant. Anal." last Am. ed., p. 279.

† Fresenius, "Quant. Anal." last Am. ed., p. 288, Fig. 51. In our apparatus, the right-hand tube is bent at about an inch from its junction with the rubber connection.

‡ To obtain sharp results by Zimmermann's method it is necessary that the solution should not be warm.

If iron alone is to be determined in an iron ore, it is not necessary to separate the silica when the ore is decomposed by chlorhydric acid. The very finely pulverised ore is simply boiled with concentrated chlorhydric acid till decomposed, the resulting liquid and silica washed into a flask and the solution reduced and titered as described. When it is necessary to use a flux it is advisable to separate the silica.—*American Chemical Journal*.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, December 9th, 1882.

Prof. CLIFTON, President, in the Chair.

New members.—Mr. H. E. Harison, B.Sc.; Mr. S. T. H. Saunders, M.A.

Prof. G. FORBES read a paper on the "*Velocity of Light of Different Colours*." The author concluded from his experiments, described to the Society a year ago, that blue rays travel quicker than red rays. M. Cornu had endeavoured to explain this result by peculiarities of the apparatus employed, but this explanation seemed doubtful. It was suggested that the experiments might be repeated with such modifications of the apparatus as would set the question at rest.

Profs. AYRTON and PERRY read a paper on the "*Resistance of the Voltaic Arc, or the Opposition Electromotive Forces set up*." The electromotive force was measured by a voltmeter connected between the terminals of the lamp. Keeping the width of arc constant the E.M.F. was found to diminish as the current increased. Keeping the current constant the E.M.F. increased rapidly at first with an increasing width of arc, and afterwards more slowly. The authors gave a curve representing the change. About 80 volts are required to produce an arc of $\frac{1}{4}$ inch. For further increase of arc, E.M.F. is therefore proportional to increase of length of arc.

The authors also read a paper on the "*Relative Intensities of the Magnetic Field produced by Electro-magnets when the Current, Iron Core, and Length of Wire, &c., are Constant, but the Wire Differently Distributed*." In (a) case the wire was wound uniformly from end to end; in (b) case it was wound from the middle to one end; in (c) case it was wound only at both ends; in (d) case it was wound only at one end. The field was measured along a line running through the axis of the poles beyond the magnet. Of the above plans, a gave the strongest field except at short distances, when *b* was best.

Profs. AYRTON and PERRY also exhibited a set of three Faure accumulators, in series feeding 20 Swan lamps, each lamp giving over one candle-power. The electromotive force of each cell was about 2 volts.

Next meeting January 27, 1883.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 17, 1882.

H. E. ROSCOE, Ph.D., LL.D., F.R.S., &c., President, in the Chair.

"Note on the Development of Living Germs in Water," by Dr. R. ANOUS SMITH, F.R.S.

In a Report on proceedings under the Rivers Pollution Prevention Act, I mention my wish to develop germs of living things in water as a test for purity. The quotation

is from a paper printed by this Society in 1867. The results were correct and useful, but not striking enough to attract much attention, although I think chemists have not been sufficiently active in using the microscope. Having long seen its importance, I confess to having done too little with it. In a Report under the Alkali Act during the year 1873, I mention a second attempt to render the existence of organic matter more perceptible by using the air washings to act upon sugar, and after many trials I was disappointed; still I came to the conclusion "that the air of a town influences fermentation to a certain extent."—Tenth Report, p. 43.

I neglected this development also too much, but Dr. Koch, of Berlin, has shown us how to preserve the indications of organic vitality by the use of gelatin. I believe he was the first to use it. It is from Dr. Koch, at any rate, that I learned the use of gelatin. About 2½ per cent of gelatin well heated in a little water is mixed with the water to be tested, and the mixture forms a transparent mass, which is not movable like the water itself. When soluble or unobserved matter develops from the organic matter of the waters and makes itself visible in a solid and insoluble form, it does not fall to the bottom, but each active point shows around it the sphere of its activity, and that sphere is observed and remains long. The gelatin preserves to us the whole action, so far as the more striking results are concerned, and keeps a record, for a time, both of the quality and intensity of life in the liquid. I speak at present of the more striking effects, which are clear and abundant, every little centre of life making itself clear to the eye, and sometimes expanding its influence to reach both sides of the tube. It seems to me now essential that all chemical examinations of water should be supplemented by an enquiry, like this of Dr. Koch's, into the comparative activity of the living organisms. How far this may go it would be absurd to attempt to say, and I never have much hope of a man who writes about the future of truth; he evidently attempts too much. I am satisfied to bring forward such facts as I know in the present, so that chemists may not be too late in attending to the new ideas.

The water must not have too much gelatin in it, if so the action is stopped. It must not have too little, if so the gelatin becomes liquid too soon and the action of the individual centres is not observed. When a centre acts it makes around it a sphere in some waters, and the sphere, which has the appearance of a thin vesicle, is filled with liquid. These spheres form in a day or two, according to the water, and at the bottom is a white mass containing active bacteria chiefly. The liquid filling the spheres may be taken out by a pipette and examined, as also the bacteria which lie at the bottom.

I have not examined a sufficient number of waters to give general rules, but I hope to do so. It is an investigation which would properly belong to Prof. Koch, and I should not have touched it had I not found that it brought into use my own enquiries as to fermentation, which were earlier, but may now be considered only a supplement to Dr. Koch's. This is by the use of sugar in addition to the gelatin. By this means a very great amount of gas is developed and retained in the gelatin. The striking amount of spheres and gas bubbles render the examination of water by this method less dependent on the opinion of the operator, and a photograph may be taken of each specimen and the result preserved as evidence.

At the same time I know that it is necessary to examine waters of various kinds before we make or find rules, and this slight account is a mere beginning. I have as yet examined no chalk water, for example, but have been confined chiefly to the Manchester district, hill water, impure brook and pond water, Mersey, Irwell, and Medlock water, and canal water. In certain specimens of Manchester supply the spheres appear on some days very few, on other days the amount is enormous and heavy; the whole of the tube in which the experiment is made is filled with spheres. At such times the water is

highly impure and complained of by the public. We have a very easy proof therefore of the value of this test.

The photograph would be a visible report made by nature when the water has active organisms in it. The globules do not show themselves in strong sewer water, but the whole mass becomes turbid and the surface of the gelatin becomes liquid and full of life. This liquid condition gradually increases until the whole is reached. We have therefore two striking conditions well marked out.

A third may be said to exist, but it is often a mere beginning of the globules. This is shown by the formation of a small white opaque point. If this point is examined it is seen to be full of life like the lower part of the spheres and the fluid portion of the gelatin when this fluidity begins on the surface.

I find, also, that the solidity or fluidity of the gelatin is an important indication. This is known by the depth to which a certain weight will sink in it.

I use the word bacteria at present because, although I have observed various forms, I do not intend to investigate the separate functions of each.

At present this mode of examining water seems to me to be far more important than the chemical, more decided and telling, but we cannot neglect the chemical.

An account of a few specimens is given here.

Specimen 1.—25 c.c. gelatin solution=2½ p.c. solid + 25 c.c. distilled water+5 m.grms. sodium phosphate.

After two days a few white spots appeared.

After three days 3 or 4 small spheres appeared, containing living bacteria.

After four days spheres enlarged, and a deposit forming at the bottom of them very full of bacteria.

After six days the surface of the jelly was beginning to give way.

After eight days the surface layer was liquid to the depth of a millimetre, but the rest of the gelatin was still firm, with no smell; liquid layer alkaline.

Specimen 2.—25 c.c. gelatin+25 c.c. Manchester water + 5 m.grms. sodium phosphate.

After one day the tube contained a few minute specks.

After two days a number of minute spheres, not to be counted, appeared, and a turbid band was formed near the surface of the jelly, which was very rich in living bacteria.

After three days spheres became larger and the whole of the gelatin was softened; a number of air bubbles appeared also.

After four days air spheres had risen to surface, bacteria spheres disappeared, leaving the liquid jelly turbid, and smelling offensively; liquid alkaline.

Specimen 3.—25 c.c. gelatin+25 c.c. Manchester water + 5 m.grms. sodium phosphate after filtration through spongy iron.

The result here resembled that of the distilled water.

25 c.c. gelatin+25 c.c. Mersey water at Northenden + 5 m.grms. sodium phosphate.

After one day a turbid band appeared near the surface and a number of minute spots appeared.

After two days these spots had spheres about them.

After three days the surface layer was quite liquid and turbid and a number of discs of gas appeared. Bacteria in spots, and surface liquid.

After four days, in a somewhat similar condition, but the surface liquid possessed a very disagreeable smell.

Specimen 4.—25 c.c. gelatin+25 c.c. Bridgewater Canal water+5 m.grms. sodium phosphate.

After two days a number of spots appeared dispersed throughout the tube.

After three days the tube contained one mass of small spheres and spots.

After four days a number of discs of gas appeared, the surface layer was becoming liquid.

Specimen 5.—25 c.c. gelatin+25 c.c. Birch pond water +5 m.grms. sodium phosphate.

After one day no alteration.

After two days a few specks appeared dispersed throughout the jelly.

After three days a number of spots appeared and discs of gas, surface layer of jelly becoming liquid.

A disc of gas is formed when the gelatin remains firm, and the gas struggles for freedom.

Specimen 6.—25 c.c. gelatin + 25 c.c. Carlile's pond water, near Alexandra Park + 5 m.grms. sodium phosphate.

After one day specks appeared dispersed throughout the gelatin.

After two days numberless very minute spheres appeared.

After four days the spheres had increased in size.

After seven days a number of spheres of gas appeared.

Specimen 7.—25 c.c. gelatin + 25 c.c. ditch water, near Alexandra Park + 5 m.grms. sodium phosphate.

After one day a number of specks appeared throughout the jelly.

After two days numberless spheres appeared.

After three days the surface of the jelly had become liquid and turbid; the spheres were increasing in number.

After seven days a number of spheres of gas appeared and the whole mass was becoming liquid.

Specimen 8.—25 c.c. gelatin + 25 c.c. N. Berwick water supply + 5 m.grms. sodium phosphate.

After one day the tube seemed one mass of minute specks.

After two days a number of minute spheres appeared and a turbid band appeared near the surface of the gelatin.

After three days, spheres had increased in size; a number of discs of gas appeared.

After four days the spheres were disappearing; the surface of the jelly was becoming liquid (these spheres did not leave a deposit).

After eight days the surface layer was quite liquid, but the rest of the jelly was firm, and there were still left a number of discs of gas and a number of minute spots; smell offensive.

Specimen 9.—25 c.c. gelatin + 25 c.c. Stockport water supply + 5 m.grms. sodium phosphate.

After one day a number of minute specks appeared and a few small discs of gas.

After two days these discs of gas were getting larger, and on the third day the tube was one mass of discs of gas.

After five days the jelly was liquid and the discs of gas rose to the surface when shaken; smell disagreeable.

Specimen 10.—25 c.c. gelatin + 25 c.c. Medlock water + 5 m.grms. sodium phosphate.

After one day a number of spots appeared dispersed throughout the jelly.

After two days these spots were more decided and a distinct turbid band appeared at the surface of the jelly.

After three days a number of flattened discs of gas appeared; surface layer semi-liquid and turbid.

Specimen 11.—25 c.c. gelatin + 1 c.c. hay infusion + 24 c.c. distilled water + 5 m.grms. sodium phosphate.

After one day the surface layer of the jelly was altering; the layer was becoming turbid and liquid.

After two days the alteration was still more advanced, but the surface layer was not yet liquid.

After three days the surface layer was liquid.

After seven days a great deal of the jelly had become liquid, and white specks appeared dispersed throughout the jelly.

Specimen 12.—5 c.c. gelatin + 1 c.c. putrid urine + 24 c.c. distilled water + 5 m.grms. sodium phosphate.

After one day the surface layer was becoming turbid and liquid.

After two days, the alteration more advanced; surface of jelly semi-liquid.

After three days the jelly at the surface was quite liquid, turbid, and offensive.

This subject is being more fully developed under Dr. Koch by Dr. Rozahegyi, and chemists must prepare for a new condition of things.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 21, November 20, 1882.

The Volta Prize.—The prize of 50,000 francs instituted by the decree of June 11, 1882, in favour of the author of the discovery which shall enable electricity to be applied economically in one of the following directions: As a source of heat, of light, of chemical action, of mechanical power, as a means of the transmission of intelligence, or of the treatment of disease, will be awarded in December, 1887. The savants of all nations will be admitted to compete up to June 30, 1887. A commission nominated by the Minister of Public Instruction will be charged with examining the invention specified by each candidate, and of recognising whether it fulfils the conditions required.

Results of Experiments made at the Electric Exhibition on Incandescence Lamps.—MM. Allard, F. Le Blanc, Joubert, Potier, and H. Tresca.—Continued from the last number.

Researches on Lead Iodide.—M. Berthelot.—The author has obtained two double iodides by dissolving lead iodide in a hot concentrated solution of potassium iodide. For the first of these he gives the formula $PbI_2KI_2 \cdot 2HO$, and for the second, which is obtained at lower temperatures in long acicular crystals of a pale yellow, $2KI_3PbI_6 \cdot 6HO$. These two salts combine with each other. The author has examined the thermic phenomena which accompany their formation.

Decomposition of Cyanogen.—M. Berthelot.—The author has studied the decomposition of cyanogen by an almost continuous stream of electric sparks.

Optical Researches Relative to the Vision of Colours.—M. Chevreul.—The author gives an account of the dates of publication of his researches, touches on avic acid, points out the difference between organic chemistry and the chemistry applied to organic beings, which he teaches at the Museum, and at last enters upon botanical and zoological classification.

Chemical Studies on the Sugar-Beet.—Hippolyte Leplay.—A continuation from the last number.

Electro-chemical Deposits of Various Colours produced upon the Precious Metals.—F. Weil.—The author exhibited specimens of gold and silver jewelry, poly-chromised by his process. These colourations resist friction, moisture, air vitiated by sulphuretted hydrogen, coal-gas, &c.

A Sulpho-carbometer for Determining the Quantities of Carbon Disulphide contained in the Alkaline Sulpho-carbonates.—MM. A. Gélis and Thommeret-Gélis.—This instrument cannot be usefully described without the accompanying cut.

Action of Tri-ethyl-amine upon Symmetric Tri-chlor-hydrine, and on the Two Isomeric Di-chlor-hydric Glycides.—E. Reboul.—Instead of fixing 2 mols. of tri-ethyl-amine, symmetric tri-chlor-hydrine loses hydrochloric acid. The two isomeric di-chlor-hydric glycides resulting from this elimination follow the law of the hydrochloric ethers of the primary mono-atomic alcohols, and simply fix tri-ethyl-amine.

Production of certain Crystalline Uranates by the Dry Way.—A. Ditte.—The author gives three methods by which potassium, rubidium, lithium, and magnesium uranates can be obtained in fine yellow tables, more or less tinged with green, insoluble in water, and infusible at a white-red heat. One of the methods is by heating the

oxide U_3O_8 with sodium chloride. The uranium oxide is decomposed, and gives off oxygen, which, with the salt and the sesquioxide, forms sodium uranate. The chlorine given off at the temperature of the experiment attacks neither the oxides nor the platinum crucible. Calcium uranate is formed by heating the green uranium oxide with pure calcium chloride. There is formed a ring of crystals, which, when purified by washing with water, are calcium uranate. Strontium and barium uranates are formed in the corresponding manner.

Note on the Measurement of Schistosity in Schistous Rocks by means of their Thermic Properties.—E. Jannettaz.—Not adapted for abstraction.

Lithia, Strontia, and Boric Acid in the Mineral Waters of Contrexeville and of Schinznach.—M. Dieulafoy.—The waters of Schinznach, which are mineralised in the Trias, contain, like all waters of this class, the three bodies above mentioned.

Calcination of Alunite in Powder, intended for the Manufacture of Alum and of Aluminium Sulphate.—P. Guyot.—The author finds that a temperature of 800° gives the best results, since almost all the alumina is then found in a state capable of being attacked by acids, whilst little potassium sulphate is left in the insoluble alum.

Journal für Praktische Chemie.

New Series. Vol. xxvi, Nos. 15 and 16.

Certain New Amidic Acids, Synthetically Prepared, and Analogous in Constitution to Hippuric Acid.—Theodor Curtius.—The author gives a convenient process for purifying crude hippuric acid; a method of obtaining glycocholl from hippuric acid; contributions to the knowledge of amido-acetic acid; a process for obtaining pure silver amido-acetate; an account of the action of chlor-benzoyl upon glycocholl silver; a description of synthetic hippuric acid and its accompanying β and γ acids. He further describes the former, as hippuryl-amido-acetic acid, its derivatives, and its silver, thallium, barium, copper, and zinc salts, its ethyl-ether, and its derivative, hippuryl-glycocholl-amide. He adds a tabular view of certain reactions of glycocholl, benzoyl-glycocholl, hippuryl-glycocholl, and the γ acid.

Formation and Decomposition of Acetanilide.—N. Menschutkin.—In this memoir the author treats of the speed of the formation of acetanilide, and the influence of temperature upon it. He gives proof of the presence of a limit in the formation of acetanilide from acetic acid and aniline, and the influence of temperature upon the changes of this limit. He then considers the decomposition of acetanilide by water, and the influence of the chemical mass of the aniline and acetic acid upon the distribution, the modification of speed, and the limit of the formation of acetanilide.

The Hydrates of Glucinum Oxide.—J. M. van Bemmel.—Glucinum hydroxide resembles magnesium hydroxide more in its granular than in its gelatinous state. The former, on prolonged heating to 220° , undergoes the same changes which with magnesia only occur on intense ignition. The β -glucinum hydroxide is more similar to the sesqui-hydroxides, such as those of aluminium, &c., whilst the α -hydroxide approaches the mono-hydroxides, such as those of calcium and magnesium. The hydrate α behaves more like an ordinary chemical compound. Its composition can be expressed in a formula with simple numerical proportions, and within certain limits of temperature its composition is constant. The hydrate β does not possess the two above-named properties, and it agrees in this respect with the gelatinous hydrates of ferric oxide, &c.

The Volume-Weight of Mono-hydrated Sulphuric Acid.—Arn. Schertel.—The most concentrated acid obtained by evaporation or which passes over last on distil-

lation with a constant composition is the acid of the highest specific gravity. The liquid mono-hydrate undergoes decomposition even at 0° , or close upon its freezing-point.

Moniteur Scientifique, Quesneville.

November, 1882.

A New Law Analogous to the Law of Avogadro.—J. A. Groshans.—The author proposes the law: "At the temperature of ebullition the density of compound bodies is proportional to the sum of their atoms." As immediate corollaries he adds that for bodies of the general form $C^pH^qO^r$ the sum of the atoms is expressed by $p+q+r=n$; $p'+q'+r'=n'$. The proportion of the densities is therefore that of $n:n'$. The new law is applicable to bodies in the gaseous or the liquid state. It applies not only to bodies at the boiling-point, but more generally to all corresponding temperatures. The analogy between the new law and that of Avogadro lies in the circumstance that both regard the densities of bodies in the gaseous state; the latter, that of Avogadro, compares the densities at equal pressures and temperatures. The densities are then proportional to the molecular weights. The new law compares densities at equal pressures, but at different temperatures—at so-called corresponding temperatures, such as their boiling-points. The densities are then proportional to the sums n, n' of the component atoms. There are, however, certain divergences between the two laws: 1. The law of Avogadro considers bodies exclusively in the gaseous state, whilst the new law applies as well to the densities of liquids as to those of gases. 2. The new law divides bodies into numerous different categories, whilst the law of Avogadro seems not to do the same. The great majority of known bodies form a single category subject to this law.

Review of Biological Chemistry.—G. de Bechi and H. Gall.—A number of translations from German journals, some of which are not very recent.

Analysis of the Report of the International Jury on the Chemical Processes of Bleaching, Dyeing, Printing, and Finishing at the Exhibition of 1878.—This report appearing four years after the event contains mention of no essential modification in dyeing and printing processes. We find it stated, without any expression of censure or protest, that certain processes for black dyeing produce 400 lbs. of something from 100 lbs. of silk.

Determination of Sugars by Polarised Light.—E. Lebaigue.—The author gives procedures for saccharose, glucose, and for mixtures of saccharose, glucose, and levulose.

Industrial Society of Mulhouse.—Meeting of the Chemical Committee, September 13, 1882.—M. Rosentstiehl exhibited the plates which are to accompany his work on the sensations of colour.

M. Jaquet read the following note on the formation of chrome yellow (lead chromate) by steaming. This process is based upon the solubility of metallic citrates in alkaline citrates, and particularly in ammonium citrate. This property applies not merely to the metallic citrates, but to a number of other salts. Thus in presence of an alkaline citrate baryta is not precipitated by sulphates, nor potassium ferrocyanide by the ferric salts. The insoluble chromates are all more or less dissolved by ammonium citrate, and in general more in heat than in the cold. Zinc chromate, among others, which is little soluble when cold, dissolves with great readiness when heated. Lead chromate, on the other hand, is dissolved with much more difficulty. On submitting to the action of steam a colour composed of lead citrate, ammonium citrate, and zinc chromate, a lead chromate yellow is obtained almost as solid as that produced by dyeing. By the action of steam the lead citrate and zinc chromate dissolve in the ammonium citrate, and give by double decomposition zinc citrate and lead chromate, which is

fixed upon the fibre. The author exhibited a swatch which had been soaped at a boil for half an hour. It may be foreseen that solid greens may be obtained by adding to the colour alizarin blue.

December, 1882.

Ultramarine.—G. Guckelberger.—This extensive treatise has already appeared in *Liebig's Annalen*.

Review of Foreign Researches.—G. de Bechi.—A series of translations almost exclusively from the *Berichte der Deutschen Chem. Gesellschaft*.

The Specific Rotatory Power of Glucose.—H. Gall.—A critique on the paper by M. E. Lebaigue, in the November number. The author repudiates M. Lebaigue's correction of the figure generally received for the rotatory power of glucose.

Bulletin de la Société Chimique de Paris.

Nos. 6 and 7, October 5, 1882.

The Decomposition of Copper Acetate in Presence of Water.—D. Tommasi.—If we heat in a sealed flask on the water-bath a very dilute solution of copper acetate, containing 1 or 0.5 per cent, or even less, of the salt, we obtain acetylene among the products of decomposition. This hydrocarbon is not formed in concentrated solutions of the same salt.

Russian Chemical Society.—Meeting of Jan. 7/19, 1882.—The President, M. Boutleroff, announced that the Sokoloff prize has been awarded to M. Menschoutkine for his researches on the influence exerted by the isomerism of the alcohols and acids on the formation of the compound ethers.

The Secretary announced that MM. Beilstein, Latchinoff, and Mendelejeff are elected members of the commission for awarding the Ragosine prize, relating to lamps for burning the heavy petroleum oils.

M. Menschoutkine gave an account of the etherification of the acids with double functions.

M. Potililtzine sent in a communication on the influence of masses in the reciprocal substitution of the haloids. When a quantity of bromine greater than an equivalent is caused to act upon the metallic chlorides, the influence of the atomic weight and of the atomicity is found to be the same as when the bodies are taken in equivalent quantities.

M. Lubavine described an ore containing iron and manganese, and found immediately under the arable soil in the neighbourhood of St. Petersburg.

M. Schallfeff made a preliminary communication on the atomic volumes of the elements.

M. Alexeeff communicated the conclusion of his researches on the reciprocal solubility of liquids. He distinguishes two sorts of solutions: the one kind formed of liquids whose reciprocal solubility is considerable, and which possess the property of mixing in all proportions at relatively low temperatures; the others have a less considerable solubility, and are incapable of mixing in all proportions at any temperature soever.

M. Louguinine exhibited the apparatus which he has constructed for determining the specific heats of solids and liquids.

M. Goldstein exhibited an apparatus for washing liquids insoluble in water.

M. Stcherbatcheff described a process for purifying water so as to avoid boiler incrustations.

M. Mendelejeff described his researches on the products of distillation of six varieties of Caucasian petroleum. The light products contained in these varieties are all identical. The fraction boiling at 100° to 105° has a specific gravity of 0.751 to 0.758, whilst the fraction of American petroleum boiling at the same temperatures does not exceed 0.703 to 0.710.

Meeting of February 1/16, 1882.—M. Selezneff sent in researches on the action of sulphur upon glass.

M. Kalantaroff sent in the results of the analyses of certain Russian cheese.

M. Menschoutkine explained an attempt at determining the chemical value of the components of acids.

M. Latchinoff described the characters of iso-cholalic acid.

M. Mendelejeff exhibited an apparatus for demonstrating the phenomenon of the diffusion of gases.

M. Alexeeff described his researches on phenol hydrate. He has also studied the influence of the physical state of a substance upon its solubility. He considers that the solution of a body does not necessarily contain it in a liquid state.

M. Laboudsky described the product formed at the expense of the combined carbon of cast-metal when decomposed by mercuric chloride.

M. Wagner gave a communication on the law of the oxidation of acetones announced by M. Popoff.

Nos. 8 and 9, November 5, 1882.

Double Salts formed by the Haloid Salts of Mercury.—M. Berthelot.—A thermo-chemical paper which has already been briefly noticed.

Russian Chemical Society.—Session March 4/16, 1882.—M. Mendelejeff, on behalf of the Commission for examining lamps for burning the heavier petroleum oils, reported that none of them fulfilled the conditions of the Ragosine prize.

M. Radoulowitch sent in a memoir on the formation under certain conditions of hydrogen peroxide in the oxidation of terebenic carbides.

M. Bardsky had experimented on the oxidation of essential oils in contact with air.

M. Menschoutkine communicated certain facts relating to the application of the theories of Bergmann and Berthollet to chemical reactions. The author has studied the action of two different bases upon the same acid, the bodies reacting being taken in molecular quantities, and forming a homogeneous system during the whole duration of the experiment. According to the nature of the bases and of the acids he has observed either a complete displacement of one base by the other, conformably to the theory of Bergmann and the principle of maximum work of M. Berthelot, or a distribution of the acids between the bases according to Berthollet. None of these theories taken separately suffices to explain the experimental results.

M. Kabloukoff announces that on passing a mixture of the vapours of methylic alcohol and of air through a heated tube filled with platinised asbestos, he obtains notable quantities of oxy-methylene.

According to M. Loubavine the crystalline acid resulting from the action of ammonium cyanide and sulphuric acid upon glyoxal, is glycoll.

M. Loubavine proposes a formula for glyoxaline based upon the researches of M. Goldschmidt.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale. 3e Série. Tome ix., September, 1882.

This issue contains no chemical matter with the exception of a paper by Dr. G. Lunge on the German alkali industry, taken from the *Journal of the Society of Chemical Industry*.

MEETINGS FOR THE WEEK.

THURSDAY, 28th.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.
— London Institution, 7.
SATURDAY, 30th.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.

ERRATA.—Page 272, col. 1, line 12 from top, for 0.37 read 0.037; col. 2, line 5 from top, for 0.5 read 0.05.

THE CHEMICAL NEWS.

Vol. XLVI. No. 1235.

OXFORD

ON THE ORIGIN OF THE HYDROCARBON
FLAME SPECTRUM.*

By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and
J. DEWAR, M.A., F.R.S.,
Jacksonian Professor, University of Cambridge.

In previous communications† to the Society we have described the spectra of what we believe to be three compound substances, viz., cyanogen, magnesium-hydrogen, and water.

In these investigations our chief aim has been to ascertain facts, and to avoid as far as possible adopting any special theory regarding the genesis of the spectra in question. Thus, in speaking of the magnesium-hydrogen spectrum, which consists of three sets of flutings closely resembling in character the flame spectrum of hydrocarbons, we remark:—"We have been careful to ascribe this line and its attendant series to a mixture of magnesium and hydrogen rather than to a chemical compound, because this expresses the facts, and we have not yet obtained any independent evidence of the existence of any chemical compound of those elements."

In dealing with the cyanogen spectrum, we sometimes refer to it as the "nitro-carbon spectrum," in order to convey that "we are dealing with a spectrum invariably associated with the presence of nitrogen and carbon, in such conditions that chemical union takes place." Finally, in summing up our observations on the spectrum of water, we remark:—"In writing of this and other spectra which we have traced to be due to compounds, we abstain from speculating upon the particular molecular condition or stage of combination or decomposition which may give rise to such spectra."

The difficulties we have met with in endeavouring exhaustively to clear up many apparently simple spectroscopic problems, on a basis of fact as opposed to theory, is further illustrated in the concluding remarks of our paper entitled "Investigations on the Spectrum of Magnesium," wherein the following passage occurs:—"The chemical atoms of magnesium are either themselves capable of taking up a great variety of vibrations, or are capable by mutual action on each other, or on particles of matter of other kind, of giving rise to a great variety of vibrations of the luminiferous ether; and to trace satisfactorily the precise connection between the occurrence of the various vibrations and the circumstances under which they occur, will require yet an extended series of observations." (*Proc. Roy. Soc.*, vol. 32, p. 203).

Specific spectra have been satisfactorily proved to emanate from the compound molecules of cyanogen, water, and magnesium-hydrogen, so far as we can interpret in the simplest way the many observations previously detailed. The fact that a fluted spectrum is produced under certain conditions, by a substance which does not give such a spectrum under other conditions, is of itself a proof that the body has either passed into an isomeric state or has formed some new compound; but we are not entitled to assert, without investigation, which of these two reasonable explanations of the phenomena is the true one.

* A Paper read before the Royal Society, Dec. 22, 1882.

† "On the Spectra of the Compounds of Carbon with Hydrogen and Nitrogen." I. and II. *Proc. Roy. Soc.*, vol. 30, pp. 152, 494. "On the Spectrum of Carbon." *Ibid.*, vol. 33, p. 403. "General Observations on the Spectrum of Carbon and its Compounds," *Ibid.*, vol. 34, p. 123. "On the Spectrum of Water," *Ibid.*, vol. 30, p. 480, and vol. 33, p. 274. "Investigations on the Spectrum of Magnesium," *Ibid.*, vol. 32, p. 189.

There is, however, a spectrum to which we have had occasion to refer in the papers on the spectra of the compounds of carbon, which closely resembles that of a compound substance, and which we, in common with some other spectroscopists, have been led to attribute to the hydrocarbon acetylene, without, however, being able to bring forward such rigid experimental proofs of its origin as we have adduced in the case of the three substances above referred to. In other words, the experimental evidence that the hydrocarbon flame spectrum was really due to a hydrocarbon was always indirect. Thus, we showed that many flames containing carbon, such as those of hydrogen mixed with bisulphide of carbon or carbonic oxide, and the flame of cyanogen in air, did not give this spectrum, and these particular flames are known, from the investigations of Berthelot, to be incapable of generating acetylene under conditions producing incomplete combustion. On the other hand, we found that a flame of hydrogen mixed with chloroform, which easily generates acetylene, gives the hydrocarbon flame spectrum in a very marked manner, and it is known that the ordinary blowpipe flame, in which the same spectrum is well developed, contains this hydrocarbon.

These and other experiments point to the intimate relation of hydrogen and carbon in the combined form of acetylene to the production of this spectrum during combustion. In our various observations on the spectrum of the electric arc taken in different gases, the flame spectrum was always noticed, and seemed to be independent of the surrounding atmosphere. In the mode in which those experiments were conducted, it was easily shown that the carbons were never free from hydrogen, and that the gases always contained traces of aqueous vapour. Under these conditions acetylene is formed synthetically during the electric discharge, the line spectrum of hydrogen being absent; so that we were never convinced that the spectrum was not due to the former substance.

It is well to remark in passing, that our previous work on the spectrum of the carbon compounds was mainly directed to that particular spectrum which is characteristic of the flame of cyanogen, and only indirectly to the flame spectrum of hydrocarbon. We were further supported in connecting the latter spectrum with acetylene, by observing that cyanogen compounds are continuously formed when the arc discharge takes place in gases containing nitrogen, and that in all probability their formation is due, as Berthelot has shown, to a reaction taking place between acetylene and nitrogen. Berthelot is positive in his assertions that cyanogen is never formed by a direct combination between carbon and nitrogen, and any such apparent combination is due to impure carbon, and the presence of an imperfectly dried gas; in other words, hydrogen is essential to the production of cyanogen under such conditions according to the views of Berthelot. Such considerations led us to suggest the following view, expressed at the time the experiments were made, as to the origin of the hydrocarbon flame spectrum.

"The mere presence of the latter spectrum feebly developed in the electric discharge in compounds of carbon supposed to contain no hydrogen, appears to us to weigh very little against the series of observations which connect this spectrum directly with hydrocarbons." (*Proc. Roy. Soc.*, vol. 30, p. 160).

"The arc in the middle of a magnesia crucible often shows no trace of the hydrocarbon set, although the cyanogen are strong. If, however, puffs of air or carbonic acid are passed into the arc, the hydrocarbon lines are produced."

"When the hydrocarbon spectrum is strong the brilliancy and number of the cyanogen groups that are visible are undoubtedly increased, so that the one variety of vibrations seems to affect the other. This is easily accounted for by the chemical interaction which takes place between acetylene, nitrogen, and hydrocyanic acid. The hydrocarbon spectrum is brought out at once in the magnesia crucibles by moistening one of the poles. All

such actions seem to show that hydrogen is essentially connected with the production of this fluted spectrum just as nitrogen is with the cyanogen series." (*Ibid.*, vol. 34, pp. 126, 127).

The fact that carbonic oxide, which is one of the most stable binary compounds of carbon, forms a distinct spectrum of a character similar to that of the flame spectrum, tended to support the view that the flame spectrum might originate with acetylene. The similarity in the character of the magnesium-hydrogen spectrum to that of the hydrocarbon flame spectrum induced us to believe that they were due to similarly constituted compounds, and seeing we felt sure about the accuracy of the view which assigns the former spectrum to some compound of magnesium with hydrogen, we accepted the analogy in favour of the supposition that acetylene is the substance which produces the flame spectrum; or, at any rate, that acetylene is a necessary concomitant of the reaction taking place during its emission, and consequently might give rise to this peculiar spectrum.

Having examined this question in the way described, we adopted the view of Angström and Thalén as to the genesis of this spectrum in opposition to the views of Atfield, Morren, Watts, Lockyer, and others, who held that this the spectrum was really due to the vapour of carbon. The delicate character of the experiments which were required to discover the origin of the peculiar set of flutings in the more refrangible part of the spectrum of cyanogen made it apparent that, whatever view as to the origin of the hydrocarbon flame spectrum were adopted by different workers, it could not be regarded hitherto as experimentally proved which was the correct one. In referring to the theory that carbon vapour is the cause of the peculiar spectrum of cyanogen, we remarked: "Now, the evidence that carbon uncombined can take the state of vapour at the temperature of the electric arc is at present very imperfect. Carbon shows at such temperatures only incipient fusion, if so much as that, and that carbon uncombined should be vaporised at the far lower temperature of the flame of cyanogen is so incredible an hypothesis that it ought not to be accepted if the phenomena admit of any other probable explanation." (*Proc. Roy. Soc.*, vol. 30, p. 506).

With the object of being able to exhaust this question, a special study was subsequently made of the ultra-violet line spectrum of carbon, in order to ascertain whether any of its lines could be found in the spectra of the arc or flame. We have found that the ultra-violet lines of metallic substances have, as a rule, the greatest emissive power, and are often present when no trace of characteristic lines in the visible part of the spectrum can be detected. If carbon resembled the metals in this respect, then we might hope to find the ultra-violet lines belonging to its vapour, thus enabling us to detect the volatilisation of the substance at the relatively low temperatures of the arc and flame. The test experiments made on this hypothesis are recorded in the paper entitled "General Observations on the Spectrum of Carbon and its Compounds." It is there shown that some seven of the marked ultra-violet spark lines of carbon occur in the spectrum of the arc discharge, although one of the strongest lines, situated in the visible portion of the spectrum at wave-length 4266, could not be found. Further, it is proved that the strongest ultra-violet line of carbon does occur in the spectrum of the flame of cyanogen fed with oxygen. Thus it seems probable that the same kind of carbon molecule exists, at least in part, in the arc and flame, as is found to be produced by the most powerful electric sparks, taken between carbon poles or in carbon compounds.

Now the spark gives us the spectrum which is associated with the highest temperatures, and therefore it is assumed that this spectrum is that of the simplest kind of carbon vapour. If that be the case, we cannot avoid inferring that denser forms of carbon vapour must exist in arc and flame, emitting, like other complex bodies, a fluted, in contrast to a line, spectrum; or rather that the two dis-

tinct kinds of spectra may be superposed. Such considerations showed that a series of new experiments and observations must be made with the special object of reaching a definite conclusion regarding the origin of the flame spectrum, and the following paper contains a summary of the results of such an inquiry.

Vacuous Tubes.

We have heretofore laid little stress on observations of the spark in vacuous tubes on account of the great uncertainty as to the residual gases which may be left in them. The film of air and moisture adherent to the glass, the gases occluded in the electrodes, and minute quantities of hydrocarbons of high boiling-point introduced in sealing the glass, may easily form a sensible percentage of the residue in the exhausted tube, however pure the gas with which it was originally filled. The excessive difficulty of removing the last traces of moisture we learnt when making observations on the water spectrum, and the almost invariable presence of hydrogen in vacuous tubes is doubtless due in great measure to this cause. Wesendonck (*Proc. Roy. Soc.*, vol. 32, p. 380), has fully confirmed our observations as to this difficulty. By a method similar to that employed by him, we have, however, succeeded in so far drying tubes and the gases introduced into them that the hydrogen lines are not visible in the electric discharge. For this purpose the (Plücker) tube was sealed on one side to a tube filled for some six or eight inches of its length with phosphoric anhydride, through which the gas to be observed was passed, and on the other side to a similar tube full of phosphoric anhydride, which was in turn connected by fusion to the (Sprengel) pump. To dry the gas it is not enough to pass it through such a tube or even a much longer one full of phosphoric anhydride; it has to be left in contact with the anhydride for several hours, and to get the adhering film of moisture out of the tube it has to be heated after exhaustion while connected, as above described, with the drying tubes up to the point at which the glass begins to soften, and kept at near this temperature for some time. To get most of the gases out of the electrodes the tube must be exhausted and sparks passed through it for some time before it is finally filled with the gas to be observed. Even when these precautions have been observed, the lines of hydrogen can often be detected in tubes filled with gases which should contain no hydrogen. The general result of our observations on the spectra observed in tubes so prepared is that the channelled spectrum of the flame of hydrocarbons is not connected with the presence of hydrogen; it does not come and go according as hydrogen is or is not present along with carbon in the way that the channelled spectrum of cyanogen comes and goes according as nitrogen is present or absent. Our observations confirm those of Wesendonck on this point.

A tube filled with hydrogen containing a small percentage of cyanogen and exhausted, was found to give plainly the seven channellings in the blue and six channellings in the indigo characteristic of cyanogen, and the hydrogen lines of course strongly, but no more than a trace of the brightest green line of the spectrum of the flame of hydrocarbons. The use of a Leyden jar brought out no more. Continued sparking made no sensible difference, the cyanogen spectrum remained, the green line did not alter: and no other line of the spectrum of the hydrocarbon flame appeared. Tubes filled with carbonic oxide exhibit in general at different stages of exhaustion the following phenomena. When the exhaustion is commencing and the spark will just pass, the spectrum is usually that of the flame of hydrocarbons and nothing else. As the exhaustion proceeds the spectrum of carbonic oxide makes its appearance superposed on the former, and gradually increases in brilliance until it overpowers, and at last at a somewhat high degree of exhaustion, entirely supersedes the flame spectrum. This is when no jar is used. In the earlier stages of exhaustion the effect of the jar is to increase the relative brilliance

of the flame spectrum and diminish that of the carbonic oxide spectrum, and at the same time to bring out strongly the lines of oxygen and carbon; at a certain stage of the exhaustion, when the flame spectrum is very weak without the jar, the effect of the jar is to bring it out again but without sensibly enfeebling the carbonic oxide spectrum, and without bringing out the carbon lines. At a still higher stage of exhaustion, when the carbonic oxide spectrum is alone seen without the jar, the flame spectrum is sometimes, not always, brought out by putting on the jar, though the carbon lines again show well. At this stage, at which the flame spectrum is not seen at all, the distance between the strise in the wide part of the tube is considerable, and much metal is thrown off the electrodes, which are rapidly heated by the discharge. Some of these tubes were filled with carbonic oxide made by heating a mixture of potassium oxalate and lime contained in a prolongation of the tube containing the phosphoric anhydride, and thus were filled from a mixture of sodium oxalate and sulphuric acid heated in a flask sealed to a long tube, which had the middle part filled with quicklime and the two ends filled with phosphoric anhydride. After all the air was expelled and the flask had been sealed off, the quicklime was heated to absorb the carbonic acid. These tubes showed no trace of the cyanogen flutings at any stage of exhaustion, either to the eye or in photographs of the spectrum. Nevertheless, in the earlier stages of exhaustion, some of such tubes do show, when the jar is used, a group of three lines in the indigo which is seen in the flame of cyanogen, and has formerly been described by us as part of the spectrum of cyanogen. We must now, however, retract the opinion that this group is due to cyanogen. We have before noted (*Proc. Royal Society*, vol. 34, pp. 125, 127) that these three lines are seen under many different circumstances when the cyanogen flutings are absent, and as the flutings also are frequently seen without the three lines, it seems that the three lines belong to some other spectrum than the flutings, and as we have now found them where nitrogen has been carefully excluded, we are forced to attribute them either to carbon or some compound other than cyanogen. In one case a very little copper nitride was introduced into the one end of the drying tube, and after the whole had been filled with gas and the generating flask sealed off, the nitride was heated so as to mix a small quantity of nitrogen with the carbonic oxide. In the spectrum of this tube the cyanogen flutings were not visible to the eye, but the ultra-violet set between K and L came out plainly in the photographs.

No hydrogen line could be detected in it. This is remarkable, because Berthelot did not find that cyanogen is generated by electric sparks in a mixture of nitrogen and carbonic oxide unless hydrogen be also present. It would, however, be rash to assume that no trace of hydrogen was present because the lines of hydrogen were not visible in the spectrum, since we know by experience that the electric discharge does not always light up all that is in a tube. Mercury, for instance, must be present in all these tubes, but its lines do not usually show until the exhaustion is carried to a high degree. One tube was filled with nitrogen with which was mixed a small percentage of cyanogen obtained by heating a little mercury cyanide placed at one end of the drying tube. This tube gave well the channellings in the blue and indigo characteristic of cyanogen, but neither the hydrogen lines nor the spectrum of the hydrocarbon flame. The cyanogen seems to be scarcely at all decomposed by the spark when thus diluted, for the carbon lines were not brought out by the use of a jar, and the cyanogen spectrum remained after continued sparking. It is well to remark in passing that Berthelot found it exceedingly difficult to get acetylene from a mixture of cyanogen and hydrogen at atmospheric pressure. In order to make this experiment succeed, short and very powerful sparks must be continued for some hours. In a tube filled with carbonic oxide mixed with a little air imperfectly dried, when not too highly

exhausted the carbonic oxide spectrum, that of the flame of hydrocarbons, and that of cyanogen, may all be seen at once superposed when no jar is used. With a jar and a tolerably high exhaustion the carbonic oxide spectrum, the hydrocarbon flame spectrum, and the carbon line spectrum, may all be seen at the same time. All the foregoing observations were made when the tubes were viewed end on and the image of the narrow part of the tube thrown on the slit by a lens. Tubes filled with carbon disulphide and carbon tetra-chloride at reduced pressures have been examined by us, but these compounds of carbon are very quickly decomposed by the spark, so that few observations can be made with one tube. If the exhaustion is not carried very far the spectrum of the hydrocarbon flame is seen both in carbon disulphide and in carbon tetra-chloride, when all the precautions above mentioned have been taken to remove moisture, and when no trace of the hydrogen spectrum is visible. At higher exhaustions the spectrum is a faint continuous one, and together with that of sulphur or chlorine as the one or other is present. The spark taken without condenser between electrodes near together in wide tubes filled with saturated vapour of carbon disulphide or carbon tetra-chloride dried with phosphoric anhydride and deprived as completely as possible of air by pumping or boiling out, shows this spectrum of the flame of hydrocarbons brightly but in tubes filled with carbonic acid gas from ignited sodium carbonate and boric anhydride and sealed off at a high temperature, the spectrum is that of carbonic oxide together with that of oxygen.

Spectrum of the Spark in Compounds of Carbon at Higher Pressures.

In the spark taken between poles of purified graphite in hydrogen, the spectrum of hydrocarbon flames is seen, and it increases in brilliance as the pressure of the gas is increased up to ten atmospheres, and continues bright at still higher pressures so far as we have observed, that is, up to twenty atmospheres. The spark without condenser in carbonic oxide at atmospheric pressure, shows both the spectrum of carbonic oxide and that of the hydrocarbon flame; and as the pressure of the gas is increased, the former spectrum grows fainter, while the latter grows brighter, no jar being used. The line spectrum of carbon is also visible. At the higher pressures the flame spectrum predominates and is very strong. The observations were carried up to a pressure of twenty-two and a half atmospheres. On letting down the pressure, the same phenomena occur in the reverse order. All the parts of the flame spectrum, as seen in a Bunsen burner, are increased in intensity as the pressure is increased. The fact that the effects of high pressure are so similar to those produced by the use of a condenser at lower pressures, seems to point to high temperature as the cause of those effects. But against this, we have the fact that at reduced pressure we get in carbonic oxide, the carbonic oxide spectrum and the line spectra of carbon and oxygen simultaneously, without that of the hydrocarbon flame. As we cannot doubt that a very high temperature is required to give the line spectrum of carbon, we must suppose that reduced pressure is unfavourable to the stability of the molecular combination, whatever it be, which gives the hydrocarbon flame spectrum. Wesendonck has remarked (*loc. cit.*) that in carbonic acid at pressures too low for the flame spectrum to be developed without a jar, it is only in the narrow part of the tube that the use of a jar brings out that spectrum. It would appear, therefore, that the constraint, due to the confined space in which the discharge occurs, has the same effect, in regard to the stability of the combination producing the spectrum in question, as increase of pressure.

Cyanogen Flame Spectrum.

Our former observations "On the Flame Spectrum of Cyanogen Burning in Air" were made on cyanogen gas, prepared from well-dried mercury cyanide, which was

passed over phosphoric anhydride, and burnt from a platinum jet fused into the end of the tube. We observed what Plücker and Hittorf had noted, that the hydrocarbon bands were almost entirely absent; only the brightest green band was seen, and that faintly. When gaseous cyanogen is liquefied by the direct pressure of the gas, the researches of Gore (*Proc. Roy. Soc.*, vol. xx., p. 68) have shown that it is apt to be contaminated with a brownish, treacley liquid, which probably arises from the imperfectly purified or dried cyanide of mercury. In order to obtain pure cyanogen we have prepared quantities of liquid cyanogen, not by compression, but by passing the already cooled gas into tubes placed in a carbonic acid and ether bath. By this method of condensation any easily liquefiable substances are isolated, and any permanently gaseous substance escaped. The samples were sealed up in glass tubes into which different reagents were inserted. After such treatment the cyanogen was used for the production of the flame in dry air or oxygen. The liquid cyanogen was left in contact with phosphoric anhydride, Nordhausen sulphuric acid, and ordinary sulphuric acid. By means of a special arrangement of glass tubing surrounding the flame dry oxygen could be supplied, or oxygen made directly from fused chlorate of potash could, by means of a separate nozzle, be directed on to the flame, and thus perfectly dry and pure gases used for combustion. Liquid cyanogen which had remained in presence of the above reagents gave only the single green hydrocarbon line faintly in dry air, all the cyanogen violet sets being strong. When oxygen made directly from the chlorate of potash was directed on to the flame all the hydrocarbon flame sets appeared with marked brilliancy. The set of lines which we have formerly referred to as the three set of flutings of the cyanogen spectrum, show marked alteration of brilliancy with variations in the oxygen supply. Thus, liquid cyanogen purified by the action of the above reagents does yield the spectrum of hydrocarbons on combustion in pure oxygen. From the great precautions we have taken we feel sure that the amount of combined hydrogen in the form of water or other impurities in the combining substances must have been exceedingly small, and that the marked increase in the intensity of the flame spectrum when oxygen replaces air is essentially connected with the higher temperature of the flame, and is not directly related to the amount of hydrogen present. This being the case, it must be admitted that the flame spectrum requires a higher temperature for its production during the combustion of cyanogen than that which is sufficient to cause a powerful emission of the special spectra of the molecules of cyanogen. Now, the two compounds of carbon which give the highest temperature on combustion are cyanogen and acetylene. Both of these compounds decompose with evolution of heat, in fact they are explosive compounds, and the latent energy in the respective bodies is so great that if thrown into the separated constituents a temperature of between four and five thousand degrees would be reached. The flames of cyanogen and acetylene are peculiar in respect that the temperature of individual decomposing molecules is not dependent entirely on the temperature generated by the combustion which is a function of the tension of dissociation of the oxidised products, carbonic acid and water. We have no means of defining with any accuracy the temperature which the particles of such a body may reach. We know, however, that the mean temperature of the flames of carbonic oxide and hydrogen lies between two and three thousand degrees, and if this be added to that which can be reached by the substance independently, then we may safely infer that the temperature of individual molecules of carbon, nitrogen, and hydrogen in the respective flames of cyanogen and acetylene may reach a temperature of from six to seven thousand degrees.

A previous estimate of the temperature of the positive pole in the electric arc made by one of us was something like the same value.

The formation of acetylene in ordinary combustion

seems to be the agent through which a very high local temperature is produced, and this is confirmed by the observations of Gony on the occurrence of lines of the metals in the green cone of the Bunsen burner, which are generally only visible in spark spectra; on this view acetylene is a necessary agent in the production of the flame spectrum during combustion. The fact that the flame spectrum is often invisible when the arc is taken in a magnesia crucible, although the cyanogen spectrum is strong, but may be made to appear by introducing a cool gas or moisture, must be accounted for by an increased resistance in the arc producing temporarily a higher mean temperature. The experiments in course of execution, where the arc will be subject to a sudden increase of pressure, will, we trust, solve this difficulty.

Electric Discharge between Graphite Poles and different Gases.

When pure graphite is employed, instead of the ordinary carbon poles, and the arc discharge is taken in different gases, in the same way as was described in the first paper, "On the Spectra of the Carbon Compounds," we have noticed some slight differences which are worthy of record. In carbonic acid gas fine channellings are seen covering the whole extent of the spectrum from the low red as far as the blue set of the flame spectrum, the flutings of the one group being observable as far as the next group. The triple set of the cyanogen flame spectrum remained very strong when all the cyanogen groups in the violet had disappeared. When the carbonic acid is displaced by hydrogen the hydrogen lines appear, the hydrocarbon and triple sets remaining bright; but in this gas the flame group at 431 is particularly well marked, and the carbon line at 4266 keeps flashing in occasionally. Thus we have in the same field of view the hydrocarbon series, the hydrogen lines, and one of the strongest lines of carbon. The De Meritens intermittent arc discharge was employed in these experiments, and it is curious to note that hydrogen, instead of favouring the passage of the arc between carbon poles, really introduces some peculiar resistance, probably owing to the great reduction of temperature by the large mass of gas surrounding the arc, or because of the formation of acetylene. The arc is much shorter than in air, but the temperature seems to be correspondingly increased, as we may infer from the fact that the hydrogen and carbon lines are now very marked. The Siemens arc in air does not show the carbon line at 4266, although we have proved that some of the chief ultra-violet lines occur in this discharge. The arc taken in carbonic oxide shows the triple group along with the usual sets of the flame spectrum, without any trace of the carbonic oxide spectrum being visible. The occurrence of the triple set of lines, in the absence of other groups much more characteristic of cyanogen, makes us doubt whether they have anything really to do with nitrogen. We are inclined to think that their previous appearance when the arc was taken in glycerine containing nitro-benzole was really due to some indirect effect, and ought not to be taken as proof of the formation of cyanogen in the absence of other characteristic groups under such circumstances.

Further evidence of the high temperature of the cyanogen flame is afforded by the occurrence in the spectrum of that flame, when fed with oxygen, of a series of flutings in the ultra-violet, which appear to be due to nitrogen. The series consists of four, or perhaps more, sets, each set consisting of a double series of lines overlapping one another. The lines increase in their distance apart on the more refrangible side, otherwise the flutings have a general resemblance to the B group of the solar spectrum.

The four sets commence approximately at about the wave-lengths 2718, 2588, 2479, 2373 respectively. They are frequently present in the spectrum of the arc taken in a magnesia crucible, and show strongly in that of the spark taken without a condenser either in air or nitrogen. As they appear in the spectrum of the spark in nitrogen, whether the electrodes be aluminium or magnesium, and

do not appear when the spark is taken in hydrogen or in carbonic acid gas, they are in all probability due to nitrogen. When a large condenser is used they disappear.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY
SAMPLES OF THE WATER SUPPLIED TO LONDON,
FOR THE MONTH ENDING NOVEMBER 30TH, 1882.

By WILLIAM CROOKES, F.R.S.

WILLIAM ODLING, M.B., F.R.S., F.R.C.P.,
Professor of Chemistry at the University of Oxford;

and C. MEYMOTT TIDY, M.B., F.C.S.,
Professor of Chemistry and of Forensic Medicine at the London
Hospital; Medical Officer of Health for Islington.

To the RIGHT HONOURABLE THE PRESIDENT OF THE
LOCAL GOVERNMENT BOARD.

December 1st, 1882.

SIR,—We submit herewith the results of our analyses of the 182 samples of water collected by us during the month of November, on the days and at the times indicated, from the mains of the seven London water companies taking their supply from the Thames and the Lea.

Of these 182 samples, three were recorded as "very slightly turbid." The remaining 179 samples were found to be bright, clear, and efficiently filtered.

In Table I. we have recorded the analyses in detail of samples, one taken daily from Nov. 1st to Nov. 30th inclusive. The purity of the water in respect of organic matter has been determined by the Oxygen and the Combustion processes, and the results of our analyses by these methods are stated in columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in a previous report.

Of the 26 samples supplied by the New River Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the East London Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Chelsea Water Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the West Middlesex Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Lambeth Water Company, two were recorded as "very slightly turbid," the remaining 24 samples being well filtered, clear, and bright.

Of the 26 samples from the mains of the Grand Junction Company, the whole were found to be well filtered, clear, and bright.

Of the 26 samples from the mains of the Southwark and Vauxhall Company, the whole, excepting one which was recorded as "very slightly turbid," were found to be well filtered, clear, and bright.

In Table III. we have recorded the oxygen required to oxidise the organic matter, and the quantities of free oxygen present in the whole of the samples collected.

It will be seen that, throughout the month of November, the condition of the metropolitan water, in respect to its degree of freedom from colour and turbidity, was considerably in advance of that to which we called attention as being noticeable in some instances, during the latter part of the preceding month. As usual, indeed, in the winter season, when despite the excellent state of aëration of the water, the processes of oxidation take place more slowly, the proportion of organic matter was somewhat

high, and corresponded very closely with that found to prevail a month later in the previous year. So far, however, as the ratio of organic carbon to organic nitrogen can be depended on as a criterion, this organic matter would appear to have mainly a vegetable origin, a conclusion that is further borne out by other considerations.

We have the honour to remain, Sir,

Your obedient Servants,

WILLIAM CROOKES,
WILLIAM ODLING,
C. MEYMOTT TIDY.

ON THE DETERMINATION OF THE FLASHING-POINT OF PETROLEUM.

By JOHN T. STODDARD.

If the best method known for determining boiling-points gave trustworthy results only when size and shape of the retort, quantity of liquid, and distance from surface of liquid to the vapour delivery tube conformed to certain rigid specifications—the results varying many degrees with a change in any one of these conditions—we should feel not only that a method demanding such precision in apparatus and manipulation left much to be desired in these particulars, but also that the determinations obtained under such arbitrary conditions could be themselves but arbitrary and undeserving the name of true boiling-points.

And yet until quite recently the best apparatus devised for finding the flashing-point of petroleum presented similar and even more numerous disadvantages.* The flashing-point as given by these instruments depends upon the size and shape of the oil holder, the quantity of oil, the means of ignition, and distance of the flame or spark from the surface of the oil, as well as upon a number of minor conditions. Agreement in the determinations of a given oil by means of a given tester demands skilful and painstaking manipulation; and agreement of different testers can apparently be secured only by selecting one as arbitrary standard and adopting conditions in the others which shall give corresponding results.

The attempt has evidently been made to simulate in these testers the conditions presented in the oil reservoir of a quietly-burning lamp. But these conditions vary in every lamp, and in the same lamp at different times; moreover, it is not only in lamps as properly used and the cans and storage tanks of kerosene that explosions occur. Safety is insured only when we know that under no possible conditions, at the temperature to which it is liable to be exposed, can the oil evolve inflammable vapours. We should be able to determine the *minimum* flashing-point, and the method should be as independent of external conditions as that employed for finding the boiling-point.

The first suggestion of a principle by which this could be accomplished is due to V. Meyer.† It is saturation of air with vapour of the oil. Recognising the promise of this principle, I have studied the methods proposed for its application, paying particular attention to that recently devised by Liebermann.‡

In the method proposed by Meyer, as well as in the elaborate and clever apparatus of Haass,§ the saturation of air with vapour is effected by shaking the oil in a closed vessel. Both are dependent for reliable results upon the interval of time allowed between the shaking and the testing. The shaking repeated from degree to degree is an unpleasant feature of these methods. The apparatus

* Cf. Engler and Haass, *Zeit. Anal. Chem.*, 20, 1.

† Wagner's *Jahresb.*, 1879, 1175, and *Zeit. Anal. Chem.*, 20, 28.

‡ *Zeit. Anal. Chem.*, 21, 321.

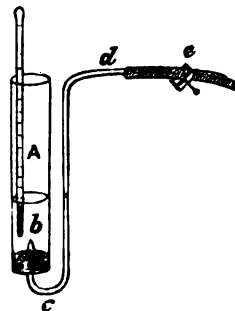
§ *Ibid.*, 20, 29.

of Haass cannot be made in the laboratory, and is expensive, costing, complete, 60 marks.

Liebermann's apparatus and method present none of these disadvantages. The air is saturated with vapour by being forced through the oil by pressure of a rubber bulb from degree to degree, while at the same instant a small flame is brought to the mouth of the oil holder. The apparatus has the recommendation of simplicity of construction and manipulation, and gives, as I have found, concordant results. Considerable care is, however, necessary to prevent spurting and regurgitation of the oil, as the air current is suddenly started and interrupted. A continuous air current, Liebermann says, although simplifying the manipulation, raises the flashing-point by preventing the accumulation of vapour enough for an explosion.

This statement I am unable to confirm, finding, on the contrary, that a continuous current of air, *if only rapid enough*, gives results identical with those of the intermittent method.

As result of my experiments I have adopted a modification of Liebermann's apparatus and method. The apparatus is shown in the cut. The cylinder is 2 to 3 c.m.



in diameter and 10 to 12 c.m. long. Just within the wooden cork the small tube contracts to a fine orifice; at *d* it is connected by rubber tubing with a source of compressed air—small water blast, hand bellows, or gasholder—the flow of which can be controlled by the pinch-cock, *e*. Its use is as simple as its construction; *A* is about one-third filled with oil, and secured in a clamp at *d*, so that it plunges in a water-bath to the level of the oil.* Air is now allowed to flow through *d c b*, and *e* adjusted so that about 0.5 c.m. foam is maintained on the surface of the oil. From degree to degree the test is made by bringing a small blowpipe flame or a match for an instant to the mouth of *A*. At the flashing-point the vapours ignite and the bluish flame runs down to the surface of the oil.

It is noteworthy that a *slow* continuous current of air gives a considerably higher flashing-point. The rapid current is effective by bringing the vapour to the mouth of the tube and diluting it sufficiently to form an explosive mixture.

The results are very satisfactory, and the apparatus so simple that it can be made in ten minutes in any laboratory. Further important advantages are the ease of manipulation, and readiness with which it can be thoroughly cleaned.

In all the apparatus suggested by Meyer's principle the determinations are largely independent of size or shape of oil holder, quantity of oil, means of ignition, distance of spark or flame from surface of oil, and rapidity of heating, and in the form above described the determination of the flashing-point becomes as easy and trustworthy an

* If plunged deeper than this, the sides of *A* above the level of the oil may become overheated, and, as they are constantly moistened by the foam, the flashing-point is, in consequence, lowered. On this account I prefer a water- to an air-bath.

operation as that of determining the boiling-point, while the results have a significance wholly wanting to those obtained by the older methods.

Determinations of Flashing-Points.

1. Comparison of Liebermann's method with the above described modification:—

	By L.'s Method.			By the Modification.		
Petroleum A.	41	40.1	40.1	40	40	39.9
	40.5	40.5	40	40	40.1	40
Petroleum B.		29			29	29

2. Influence of varying velocity of air current:—

Petroleum A.	Very slow	43
	Slow	41
	Fast enough to form 0.5 c.m. foam	40
	Very much faster	39.8
		39.5
		39.5

3. Influence of height of oil in holder:—

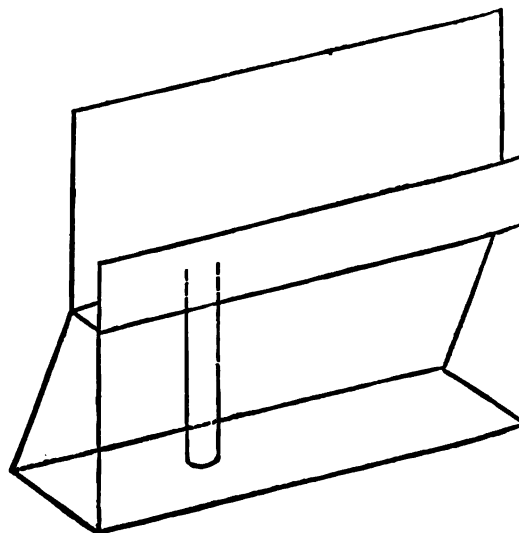
Petroleum C.	Holder $\frac{1}{2}$ full,	38.5
	" "	38.3
	" "	37.8

All determinations are in Centigrade degrees.—*American Chemical Journal*.

NOTE ON A TUBE-STAND FOR NESSLERISING.

By P. T. AUSTEN and F. A. WILBUR.

A SHORT time since, while making some determinations by Wanklyn's method of water analysis, we were much troubled by cross lights, which made it impossible to obtain satisfactory readings. After several attempts we hit upon the following form of stand, which has given the most excellent results, and which has the advantage of being easily and cheaply made. The following figure represents the apparatus.



The tall shield consists of a piece of quarter-inch board 6 inches wide, tacked to the cross-piece. The low shield is 3 inches wide. The stand and shield are painted black. Over the bottom piece a strip of ordinary window-glass, painted white on the under side, is laid. Instead of painting, which of course must be done with a pigment

not affected by the laboratory fumes, a piece of white paper may be inserted between the glass and the wood, or the wood itself may be given a coat of white paint. The latter method is in some respects the most advisable, for there is then no danger of breaking the tubes by dropping on the glass. Another advantage is that the wood may receive slight hollows so as to steady the tubes and hold them perpendicular. The whole stand can also be easily made from sheet-iron.

The tubes are ordinary 7-inch test-tubes holding about 60 c.c. They project about an inch and a half above the level of the perforated cross-piece. When filled the liquid is about level with the surface of the cross-piece. We find it convenient to mark the number of tenths of ammonia represented by the standard tube on the upright shield behind it. The standard tubes are placed in every other hole, the intermediate holes being used for the tubes containing the distillates. We are in the habit of using two stands, each containing twenty holes and ten standard tubes, the two running from 0.01 to 0.20. The tube containing the distillate, after being treated with the Nessler solution, is placed between the two standard tubes to the colour of which it approximates the most nearly, and the reading then made.

The stand is placed with the tall upright toward the light. On looking down into the tube, the colour appears with remarkable clearness and brilliancy, thus rendering the reading very accurate and satisfactory.—*American Chemical Journal*.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

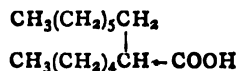
Thursday, December 21, 1882.

Dr. GILBERT, F.R.S., President, in the Chair.

THE following certificates were read for the first time:—H. C. Bond, J. T. Donald, A. H. Jackson, H. Jones, J. E. Johnson.

The SECRETARY then read a paper "*On the Condensation Products of Ceanthol (Part II.)*," by W. H. PERKIN, jun. When ceanthol is acted upon by nascent hydrogen it is well known that heptylic alcohol is produced, but, in addition, other products of higher boiling-points are formed in some quantity, and the author has accordingly investigated them. The ceanthol was first dissolved in acetic acid, and a sodium amalgam containing 2 p. ct. of sodium added. When the action was finished water was added, and the oil which separated dried and distilled at 300 m.m. pressure. The portion which distilled under 200° consisted chiefly of heptyl alcohol and ceanthol: the higher fraction contained the aldehyd $C_{14}H_{26}O$, and the alcohol $C_{14}H_{28}O$. The ceanthol was next dissolved in a large excess of ether, floated on water, and treated with sodium. The aqueous solution contained some heptylic acid. The ethereal solution was distilled at 150° to 200°, when ceanthol and heptylic alcohol came over. The temperature then rose: between 250° and 310° most of the remainder came over. This distillate was re-fractionated, and an aldehyd obtained in crystalline plates melting at 29.5°, distilling between 266° to 268°, and having the composition $C_{14}H_{28}O$. A second substance was also separated as an oil solidifying at -10°, boiling about 320°, reducing ammoniacal silver nitrate, and having the formula $C_{21}H_{40}O$. The author next studies the oxidation of the aldehyd $C_{14}H_{28}O$. The chief products (with chromic acid or silver oxide) were heptylic and hexylic acids, but with silver oxide an acid boiling at 300° to 310° was obtained in small quantity, with the composition $C_{14}H_{28}O_2$. By acting on the aldehyd $C_{14}H_{28}O$ dissolved in acetic acid, first with zinc slightly coated with copper and subse-

quently with sodium amalgam, an oil was obtained boiling at 270° to 275°, which analysis proved to be the alcohol $C_{14}H_{30}O$ already obtained in Part I. The author then discusses the constitution of these bodies. The solid aldehyd and the acid obtained from it are isomeric with myristic aldehyd and myristic acid; but myristic aldehyd fuses at 53.8°, the new substance at 29.5°. From the oxidation products the author considers that the acid must be heptyl-pentyl acetic acid—



The next part of the paper refers to the polymerisation of ceanthol. The solid polymer $(C_7H_{14}O)_n$, which has been previously obtained, was distilled, and from various experiments the author concludes that $n=4$, and the body has the composition $C_{28}H_{56}O_4$.

Dr. ARMSTRONG congratulated the author on having completed an arduous piece of work, which was besides very interesting, as it gave us a synthetical method for preparing the normal paraffins.

Prof. W. FOSTER then read a paper "*On the Behaviour of the Nitrogen of Coal during Destructive Distillation, with some observations on the Estimation of Nitrogen in Coal and Coke*." It is usually stated in text-books that coal contains about 2 per cent of nitrogen which, when the coal is heated in close vessels, usually comes off as ammonia. The author, however, finds that only a small fraction of the total nitrogen comes off as ammonia. Durham coal was employed, which contained 1.73 per cent of nitrogen, and left 74.46 per cent of coke. A weighed quantity of the coal was placed in a combustion tube sealed at one end, and the issuing gas was washed free from ammonia by hydrochloric acid. The gas thus freed from ammonia was passed through a second heated combustion-tube containing slaked lime: the additional ammonia thus obtained came from the decomposition of cyanogen in the gas. Taking the total nitrogen in the coal as 100, only 14.5 per cent is evolved as ammonia, 1.56 per cent as cyanogen, 35.26 is present in the coal-gas as nitrogen, whilst 48.68 per cent remains behind in the coke.

Dr. PERCY FRANKLAND said that Dr. Hoffmann in his report in connection with the Exhibition of 1862, stated that only one-third of the nitrogen was evolved as ammonia, two-thirds remaining behind in the coke, and as far as he knew nothing had been done with the subject until Mr. Foster had taken it up. He had made some combustions of the coal used by that gentleman, using the apparatus employed in the combustion of a water residue. About 0.024 grm. of coal was taken: great difficulty was experienced in getting all the nitrogen off.

Dr. ARMSTRONG suggested that as regards the results obtained everything would depend on the temperature, and it would be interesting to know how the quality of the coal affected the results.

Prof. FOSTER said that in his experiments he had endeavoured to imitate as far as possible the usual process employed in the manufacture of coal-gas. He hoped to be able to make some experiments shortly, in which he would employ a Siemens's regenerating furnace, and so have the temperature under control.

The SECRETARY then read a paper "*On the Absorption of Weak Reagents by Cotton, Silk, and Wool*," by E. J. MILLS and J. TAKAMINE. The object of the authors was the quantitative measurement of such absorption. 250 c.c. of the weak reagent (dilute sulphuric acid, dilute hydrochloric acid, or dilute caustic soda) were placed in a bottle and kept at a constant temperature; in the bottle was placed also a known weight of the tissue (usually 3 grms.). After a week or more the tissue was removed, and a known volume of the remaining liquid titrated. The diminution of strength gives, so the authors state, the amount of absorption. In the second part of the paper the authors have determined in a similar way the ratio of absorption

from mixtures of the acids. The paper contains numerous tables giving the results calculated to five places of decimals, and the mean probable errors. The paper concludes as follows:—There is thus a very intimate relation between silk and cotton—a relation which, whatever it may be in part, is shown by these changes to be, to a great extent, of a strictly chemical nature. We have, in conclusion, to express the hope that an investigation, while bearing on the one hand on questions of great technical importance, may not be without its value in the profounder future study of cotton, silk, and wool—three bodies of definite chemical composition, but whose intimate constitution still remains obscure.

Mr. Cross said the subject was extremely interesting, as bearing on the constitution of fibre. He had made experiments of a similar kind, but had found it very difficult to separate the various factors involved. He did not think that it was correct to assume that the loss in strength of the solution was an accurate measure of the absorption by the fibre, because the fibre might absorb a solution of a different density to that left outside the fibre. He had investigated the subject, and could not satisfy himself that the fibre did not take up a solution of different density to that left outside the fibre. In some experiments with aniline dyes he found that asbestos gave results similar to those obtained with some of the fibres used. The effect of the constituents of the ash seemed to have been neglected by the authors.

Dr. SCHUNCK said it was important to determine the absorption by different samples of the same fibre.

Mr. W. A. SHENSTONE then read a paper entitled "*The Alkaloids of Nux vomica. No. 2. On Brucine.*" The author has made many experiments as to the limited oxidation of brucine and strychnine, but at present without any definite results. Strecker, Liebig, and others, state that brucine, when treated with dilute nitric acid, yields, amongst other products, either methyl or ethyl nitrate or nitrite. As the formula of brucine suggested that it might be a dimethoxyl derivative of strychnine, the author proceeded to investigate the question. He finds that 1 grm. brucine, when heated with fifteen times its weight of hydrochloric acid for fourteen hours to 135°, then for thirteen hours to 145°, then seven hours to 150°, and finally seven hours to 160°, evolved 90.2 c.c. of a gas, which analysis proved to be methyl-chloride. 1 grm. of dimethoxy-strychnine should give 113 c.c. It is probable, therefore, that brucine is strychnine in which two atoms of hydrogen are replaced by two methoxyl groups, and that it has the formula—



The contents of the sealed tubes after the escape of the gas were black and usually tarry: an examination led to no satisfactory results. The author also studied the action of hydriodic acid upon brucine, but the substances formed are unstable. The author intends to examine strychnine, and thus endeavour to make out the relations of the *Nux vomica* alkaloids, since the removal of the methoxyl groups from brucine seems to give rise to bodies of such unstable character.

Dr. W. H. PERKIN then read a "*Preliminary Note on some Diazo-Derivatives of Nitro-benzyl-cyanide.*" When an alcoholic solution of nitro-benzyl-cyanide is mixed with an alcoholic solution of caustic potash, an intense crimson-red colour is produced, which gradually changes through a brownish purple to a greenish blue colour. It appeared, therefore, that some definite though unstable compound was produced, and it seemed probable that it might yield a derivative with the diazo-bodies. The alcoholic solutions of the above-mentioned bodies were mixed, and immediately afterwards an aqueous solution of diazo-benzene chloride was added until the red colour disappeared. The product was further diluted and filtered; the precipitate washed, purified by recrystallisation, and finally orange-yellow needles obtained, melting at from 200° to 202°, having the formula $C_{14}H_{10}N_4O_2$.

The constitution of this body has not yet been established, but it appears to be analogous to the phenyl-anilo-acetic nitril obtained recently by Liemann.

The SECRETARY then read a paper, "*Researches on the Induline Group.*" by O. N. WITT and E. G. P. THOMAS. The term induline is applied in commerce to a series of violet and blue dyes, distinguished by great fastness to light and atmospheric influences. Scientifically the term may be applied to all coloured compounds formed by the action of amido-azo-compounds on the hydrochlorides of aromatic amines with elimination of ammonia. In the present paper the authors give an account of their researches on the formation of amido-azo-benzene and its action on aromatic hydrochlorides. It has long been known that amido-azo-benzene, when heated with aniline hydrochloride or nitrate, produces a dark blue colouration. The authors find that invariably several colouring-matters, differing from each other both in composition and properties, are formed, and that the nature as well as the quantities of the products depend largely on the temperature at which the reaction takes place, and the manner in which it is conducted. In this paper the authors describe these various compounds and their preparation, and promise in a future communication to explain the reaction and the constitution of the products.

The Society then adjourned till January 18, 1883.

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on Wednesday evening, the 20th inst., at the Institution of Civil Engineers, Mr. J. K. LAUGHTON, M.A., F.R.A.S., President, in the Chair.

Four new Fellows were elected, and Capt. J. de Brito Capello and Mr. W. Ferrel, M.A., were elected Honorary Members.

The following papers were read:—

"*Popular Weather Prognostics.*" by the Hon. R. ABERCROMBY, F.M.S., and Mr. W. MARRIOTT, F.M.S. The authors explain over one hundred prognostics by showing that they make their appearance in definite positions relative to the areas of high and low atmospheric pressure shown in synoptic charts. The method adopted not only explains many which have not hitherto been accounted for, but enables the failure, as well as the success, of any prognostic to be traced by following the history of the weather of the day on a synoptic chart. The forms discussed are:—Cyclones, anticyclones, wedge-shaped and straight isobars. The weather in the last two is now described for the first time. They also point out (1) that prognostics will never be superseded for use at sea, and other solitary situations; and (2) that prognostics can be usefully combined with charts in synoptic forecasting, especially in certain classes of showers and thunderstorms which do not affect the reading of the barometer.

"*Report on the Phenological Observations for the Year 1882.*" by the Rev. T. A. PRESTON, M.A., F.M.S. The most important feature of the Phenological year was the mild winter. The effect of this upon vegetation was decidedly favourable, and had it not been for the gales—especially that of April 28th,—the foliage would have been luxuriant, and therefore free from insect attacks, but the contrary effect has been produced on insect life, for the scarcity of insects, especially butterflies and moths, has been the general remark of entomologists.

Mr. J. S. DYASON, F.R.G.S., exhibited a series of typical clouds in mono-chrome, and also a series of sketches of clouds in colour, made in June, July, and August, 1882.

Displacements and Deformations of Electrical Sparks by Electrostatic Action.—M. Aug. Righi describes a method by which the spark may be displaced and deformed like a flexible body if positively electrified.—*Comptes Rendus.*

CORRESPONDENCE.

USEFUL APPLICATIONS OF ELECTRICITY.

To the Editor of the Chemical News.

SIR,—Enclosed with this communication I send a small instrument similar to one which has been singularly useful in one of our Colonies, by assisting in the discovery of an ore of copper in a locality where no such substance had been suspected to exist. In the present state of the negotiations with respect to this ore I am not in a position to give more than a general outline of facts, which are as follows:—

About twelve years ago a Colonial seller put up a mill upon a stream of water that ran through his estate. This mill was for the double purpose of grinding corn and sawing wood, and was set in motion by an under-shot water-wheel, the ironwork of which seemed to decay more rapidly than usual; therefore another wheel was made with galvanised iron nails and screws, but this produced no visible change in the destruction; and nearly four years ago the subject was brought under my notice by a friend of mine, who then had just received a letter, in which the matter was casually mentioned. I immediately made a small instrument, such as I now send you, and giving this to my friend, I begged of him to ask the Colonist as a favour to suspend the instrument by a piece of catgut for three months in the current of water, and after that time to return it to me by letter. More than twelve months afterwards I received the instrument back, with an amount of information that would have prevented me from thinking of the instrument if this had been given in the first instance; for the stream was well furnished with fish, the Colonist's horses, oxen, and sheep all drank the water, and an aboriginal native man who lived in the mill also drank the water, and no injury followed. On looking at the instrument, however, I saw that the iron was corroded, and the platinum wire had become black, so I cut off the platinum wire, and having bent it to fit the concavity of a watch-glass, I caused a drop of nitric acid to run from one end of it to the other, during which course the acid gave off red fumes and became of a fine green colour. To confirm the opinion created by this effect, I added a few drops of a solution of the acetate of potash, and then put a drop of the mixture upon a piece of polished iron, which immediately became red from a coating of copper, and the subsequent use of ferrocyanide of potassium and liquor ammonia added to the evidence. I consequently wrote to say what I had found, and suggested that the banks of the river higher up might be profitably searched to see whether any small stream joined it, and I sent out six instruments with which to test any such stream if found. The result has been most satisfactory: such a stream was found about 5 miles higher up, and the water from it, in the language of the Colonist, "there and then turned the white wire red, as you looked at it," and this stream was traced to a black bog at the foot of a low hill, from the side of which the water oozed out in many places, and at a few inches below its surface the hill was found to be rock, and in the rock several veins of yellow metal were seen from quarter of an inch to 3 inches in thickness. Samples of both were sent to me, and the yellow metal proved to be copper pyrites containing about 30 per cent of copper, and the rock was mountain limestone, which information I communicated to the Colonist, and in his reply, just now received, he tells me that he is attempting to purchase the hill, without explaining his object to anyone.

In my opinion the most remarkable, and also the most important part of this discovery, is to be found in the fact that a water containing copper can be drank with impunity. The relative amount is no doubt infinitesimally small, and far beyond the reach of ordinary reagents, but

its presence in the water is indisputable, and we may perhaps usefully ask ourselves whether our prevailing fear of metallic contamination rests upon a rational foundation. Dr. Paris, in his "Pharmacologia," says—"It is a curious fact that previous to the introduction of copper works in Cornwall agues were very frequent, but since that period the disease is extremely rare, and I have heard it remarked by the men in the works, that the smoke kills all fevers;" and the Dr. then asks, "Is this owing to the arsenical fumes?"

I will now describe the mode of constructing the little instrument above-mentioned. It is formed of two kinds of wire, iron and platinum. The iron wire is of such a size that one inch of it weighs seven grains, and of the platinum wire four inches weigh three grains. A piece of each of these wires, three inches in length, is to be cut off, and one end of the iron wire is to be flattened by the blow of a hammer, after which the two pieces of wire are to be bound together, so that one end of the platinum wire rests upon and touches the flattened surface of the iron wire, when the whole being laid upon a piece of charcoal, a morsel of silver not larger than a pin's-head must be put upon the point where the two wires touch each other, and this being then lightly dusted over with powdered borax, a smart application of the blowpipe flame melts the silver and unites the wires, by which the instrument becomes at once complete, and when used requires only to have the two wires separated into the form of the letter V.

The advantages of this instrument are soon told. It costs less than twopence; it weighs about 25 grains, and can be sent by post to any part of the world, where it can be set in action by an uneducated person, and in due time returned back to this country and examined scientifically. When suspended by catgut or silk for many months in a current of water it necessarily comes in contact with several millions of gallons of that water from which by electrical agency it separates the metallic matter and stores it upon the platinum wire for future examination, so that no ordinary reagent can be compared with it in point of delicacy. By its means I have lately detected lead in the water of a hill-stream derived from a granitic source, and reputed to be singularly pure, and I have now, through the kindness of friends, several of these instruments at work in various parts of Great Britain; nor will it greatly surprise me if the much-praised hill-stream water proves to be more metalliferous than common river-water; for we must remember that river-mud ferments, and in so doing evolves sulphuretted hydrogen and hydrosulphate of ammonia, by which the metallic contaminations of the river-water are precipitated and removed, so that here, as in many other instances, we discover an example of that far-seeing Providence which has made impurity itself a means of purification. But until we know much more than we know at present of the effect of minute quantities of metallic matters upon the human constitution we had better draw no conclusions, for it may happen that the metallic impurities of hill-water (supposing them to exist) are precisely the cause of the salubrity of such water.—I am, &c.,

LEWIS THOMPSON.

Action of Phosphorus Trichloride and Tribromide upon Gaseous Hydrogen Phosphide.—P. de Wilde.—The author finds on thermo-chemical data, that the reaction given by H. Rose is impossible, unless we assume a disengagement of at least 21.4 cal. on the formation of two atoms of amorphous phosphorus. M. de Wilde finds that it is merely the vapours of liquid hydrogen phosphide contained in the spontaneously inflammable gas which react with phosphorus trichloride. The solid yellow body which Rose observed, and which he named yellow phosphorus, is a solid hydrogen phosphide.—*Cosmos Les Mondes.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. xcv., No. 22, November 27, 1882.

Reply to the Objections of M. Decharmes on my Conception of the Nature of Electricity. Proofs of the Validity of the Hypothesis serving as the Base of this Conception.—A. Ledieu.—This discussion does not admit of useful abridgment.

The General Law of the Congelation of Solvents.—F. M. Raoult.—Every substance when dissolving in a definite liquid compound, capable of solidifying, lowers its congelation-point. In all liquids the molecular lowerings of congelation due to different compounds approximate to two values, invariable for each liquid, one of which is double the other. The greater value appears most frequently, and constitutes the normal molecular lowering. The less corresponds to the case where the molecules of the dissolved body are connected two by two. The normal molecular lowering of solidification varies with the nature of the solvent. A molecule of any compound when dissolving in 100 mols. of any liquid whatever of a different nature lowers the solidification-point of this liquid by a quantity almost constant and close upon 0.62° .

Chemical Studies upon Maize at Different Stages of Vegetation.—H. Leplay.—The author treats of the formation and accumulation of crystalline sugars, reducing sugars, and starch in different parts of the plant.

Electric Motors.—Marcel Deprez.—Not suitable for abstraction.

Reform of certain Analytical Procedures used in the Laboratories of Agricultural Stations and in the Observatories of Chemical Meteorology. Memoir 4.—Volumetric Determination of the Alkaline Earthy Carbonates contained in Waters.—Aug. Houzeau.—The method depends upon the following facts:—If, to two separate solutions of calcium bicarbonate and sulphate containing the same proportion of calcium, there is added a similar quantity of a weak solution of oxalic acid, we observe a production of calcium oxalate, which appears much more rapidly in the first solution than in the second. It appeared to the author possible to utilise this difference observed in the speed of the reactions so as to determine volumetrically in flowing waters calcium and magnesium bicarbonates, whether associated or not with calcium sulphate. The method of operation differs sensibly according as the water contains merely bicarbonates, or sulphate along with the former.

First Case.—Bicarbonated Waters; Method of Operating. A.—Into 100 c.c. of water coloured with 1 c.c. of an alcoholic solution of cochineal upon which free carbonic acid has no action, we pour drop by drop a standard solution of oxalic acid (1 c.c. = 28 m.g. $6C_2O_3, 3HO$) until the appearance, easily recognised, of the stable yellow tint. The volume of oxalic acid employed shows the weight of the carbonic acid combined with bases in the state of neutral carbonates. The calcium oxalate, collected upon a filter, is determined volumetrically by means of standard permanganate (1 litre = 1.6 grm. permanganate). From the weight of the oxalic acid found we deduce that of the carbonic acid equivalent to it, and consequently that of the lime. On deducting from the total weight of the carbonic acid found by the standard oxalic acid that of the carbonic acid answering to the calcium oxalate, the difference is the carbonic acid present in magnesium carbonate. The results are exact for waters which do not contain alkaline carbonates.

B. The procedure may be simplified if approximate results are considered sufficient. By making use of a burette with a capillary orifice the standard acid may be slowly added to the decilitre of water coloured with cochineal, stopping as soon as the calcium oxalate begins to appear. After settling for three minutes we filter, and the liquid passes through clear if the paper is of good quality. The standard acid is then again added until the appearance of a new turbidity, if there still remains calcium bicarbonate. In a word, the volume of the standard oxalic acid employed for the precipitation of the lime shows the weight of the calcium carbonate; that which has been further used for producing the final yellow colouration gives the weight of the magnesium carbonate. In less than fifteen minutes we may find the respective proportions of calcium and magnesium carbonate in a water with approximate accuracy. The determination of the total combined carbonic acid remains exact, but its distribution among the bases leaves something to be desired.

Second Case.—Bicarbonated and Sulphatic Waters.—When these waters do not contain magnesium carbonate the direct titration with oxalic acid gives in an exact manner the weight of the neutral calcium carbonate. The result is different when there is present magnesium carbonate, for the soluble oxalate of this base reacts upon the calcium sulphate. It is first necessary to eliminate the calcium sulphate before proceeding to add the oxalic acid. This elimination is easily effected if to the decilitre of water to be assayed we add a suitable volume of alcohol saturated with carbonic acid which precipitates the sulphate without touching the bicarbonates, whilst ordinary alcohol precipitates an important fraction of these bicarbonates. After standing the alcoholic liquid is decanted or filtered. We take then 100 c.c., which we mix with an equal volume of distilled water, and proceed to the volumetric assay as indicated above. The titrations with oxalic acid are easily effected without stirring in flat bottomed half-litre flasks, to which a rotatory movement is given, or, better, in conical glasses of the same size, of Bohemian glass.

December 4, 1882.

Memoir on the Vision of Material Colours in Rotatory Movement, and on the Respective Speeds of Circles of which one Diametral Half is Coloured and the other Colourless.—M. E. Chevreul.—A treatise extending to 24 pages and incapable of useful abstraction.

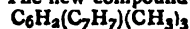
Presence of Nitric Acid and Ammonia in Water and Snow Collected in the Glaciers of the Alps.—M. Boussingault.—It appears that at great heights, say of 3000 m. and upwards, nitric acid is always absent, and ammonia when present is found in small proportions.

Chemical Studies on Maize at Different Epochs of its Vegetation.—M. H. Leplay.—Continued from the last number.

The Currents Produced by Nitrates in Igneous Fusion in Contact with Incandescent Carbon.—M. Brard.—The author setting out from the principle described in his paper of Nov. 13, has constructed what he calls a "briquette battery," by means of which he has succeeded in decomposing water.

Method of Transforming Tricalcic Phosphate into the Chlorinised Compounds of Phosphorus.—M. J. Riban.—By passing simultaneously chlorine and carbon monoxide over a mixture of carbon and tricalcic phosphate, the latter is entirely converted at a low temperature—that of the oil-bath—into phosphorus oxychloride with formation of calcium chloride and carbon dioxide.

New Hydrocarbide.—M. E. Louise.—The author has obtained benzyl-mesitylene by causing benzyl chloride to react upon mesitylene in presence of anhydrous aluminium chloride. The new compound—



forms when pure a white crystalline mass, faintly tinted with yellow, easily soluble in benzine, light petroleum ether, alcohol, ether, acetic acid, and acetone. It melts at 31°.

December 11, 1882.

Separation of Gallium.—M. Lecoq de Boisbaudran.—Will be inserted in full.

New Researches on Glairine and Baregine, and on its Formation in the Thermal and Sulphurous Waters of the Pyrenees.—M. N. Joly.—Concrete glairine is a very complex substance containing the remains of a multitude of animals and vegetables, as well as crystals of sulphur, pyrites, silica, &c.

Instance of Black appearing Orange-Red.—M. A. Trécul.—The author observed last summer a lady wearing a black veil consisting of a net-work of very close meshes and directly illuminated by the sun. All the knots of the net-work appeared externally of an orange-red, whilst the inner half remained black. The black of the dyes is a very intense blue, to which an orange-red is complementary.

Communication of M. Marcel Deprez, relating to the Transfer of Force.—M. Maurice Lévy.—Not suitable for abstraction.

Atomic Weight of Gallium.—M. P. T. Clève.—Will be inserted in full.

—
Biedermann's Central-Blatt für Agrikultur-Chemie,
Vol. xi., Part 9.

Manurial Experiments on Potatoes with Potash-Saltpetre.—Dr. Edler.—The results of the experiments were favourable both financially and as compared with soda-saltpetre.

Researches on Manuring Vineyards.—Prof. Paul Wagner.—Neither phosphoric acid nor potash have had any effect in the experiments at Bodenheim. At Nierstein the action of phosphoric acid was unfavourable, the yield being 25 per cent less than in its absence. The leaves of the vines took a yellowish colour as early as August, whilst in the unmanured portions the leaves had a normal appearance.

Comparative Manurial Experiments in the District of the Freudenberg Agricultural Association.—The addition of either potash or phosphoric acid singly did not cover the cost. Both together proved remunerative.

Experiments on the Digestion of Lupins (Freed from their Bitter Principle) by Horses, and Observations on the Comparative Working Power of the Horse when Fed on Lupins or Oats.—Dr. O. Kellner.—The comparative food value of lupins and oats does not essentially vary.

Composition of the Albumenoids of Hemp Seeds, and of the Crystalline Albumen of Hemp Seeds and Castor-Oil Nuts.—H. Ritthausen.—The crystalline albumen of hemp seed and that of the castor-oil nut appear identical; that of the pumpkin seed differs in its composition.

Cultivation of Sugar Beets.—W. Rimpau, L. Dehaussy, and B. Corenwinder.

Cultivation of the Potato.—Prof. Leydhecker, Profs. Wollny, Ring, L. Meyer, and others.—These papers are not of a chemical character.

Diseases of the Sugar Beet.—Prof. Kühn and H. Joulie.—Phenol-lime and a secret remedy have not proved successful. A copious dressing with potassic manures is recommended.

Phylloxera and its Antidotes.—Not adapted for abstraction.

Researches on Parasitic Diseases of Plants and

their Remedies.—*Silpha reticulata*, *S. atrata*, and *S. opaca* are now well known as enemies of the sugar beet.

Cosmos Les Mondes.

No. 11, November 11, 1882.

Mutual Attraction and Evaporation.—Everyone knows that the magnet attracts iron. Setting out on this principle it would seem natural to admit that the degree of attraction of an ore would be directly proportional to its richness in iron. Experience points to a contrary result. The sulphides and sulphates are less attracted by the magnet than the oxides, carbonates, and silicates, though containing more iron. No practical application has yet been made of this discovery (?), yet different ores might be mechanically separated from each other, which would much facilitate their treatment and reduction. Metals follow for evaporation the laws of other bodies. Their volatilisation requires a very high temperature. But M. Demarçay has remarked that this temperature diminishes notably with pressure. If it were practicable to smelt metals in a vacuum, a much lower heat and a smaller quantity of fuel would be required.

No. 12, November 18, 1882.

Silico-molybdates.—F. Parmentier.—The author describes the ammonium, potassium, silver, and mercurous silico-molybdates.

Solubility of Certain Mercuric Compounds in Benzol.—A. P. N. Franchimont.—Mercuric chloride, bromide, and iodide dissolve slightly in benzol when cold, and much more when it is warm, and crystallise out on slow cooling or on spontaneous evaporation. The compounds of lead and copper are insoluble in benzol.

No. 13, November 25, 1882.

The Société Générale des Telephones has seized all the telephones existing at present in the hands of all the French makers.

Preparation of Precipitated Tin.—C. Puscher.—The author uses a very dilute solution of stannous chloride, strongly acidulated, containing 150 grms. tin crystals in 68 litres of water. The sponge of tin which is deposited by the action of bars of zinc is collected without pressure in a sieve, washed in water, and then dried in heat. The powder is mixed with starch-paste, and may be used for printing or coating cloth, paper, &c.

No. 14, December 2, 1882.

Production of Gold in French Guyana.—The production of gold from the mine of French Guyana is about 2500 kilos. yearly.

The New Telephone of M. Maiche.—The description of this apparatus requires the two accompanying illustrations.

New Accumulator with Carbon Electrodes.—Dr. D. Tommasi.—The author's accumulator or secondary battery has several advantages as compared with those already in use. It weighs, bulk for bulk, from five to six times less. It presents a surface of lead exceedingly large as compared with the weight of the carbon plate, and it can be put together very rapidly.

MEETINGS FOR THE WEEK.

MONDAY, Jan. 1.—London Institution, 5.
TUESDAY, 2nd.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.
Pathological, 8.30.
THURSDAY, 4th.—London Institution, 7.
Royal Institution, 3. "Light and the Eye," by Professor Tyndall.
SATURDAY, 6th.—Royal Institution, 3. "Light and the Eye," by Professor Tyndall.

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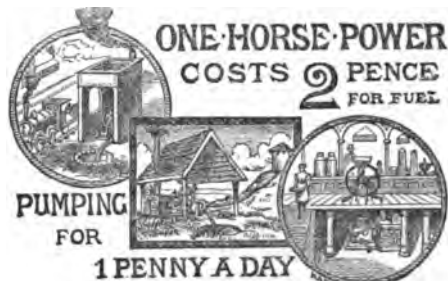
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